

July 1993/\$3.00

Mobile Radio Technology™

The journal of mobile communications technology



Trunked radio, p. 10

Using ferrite isolators

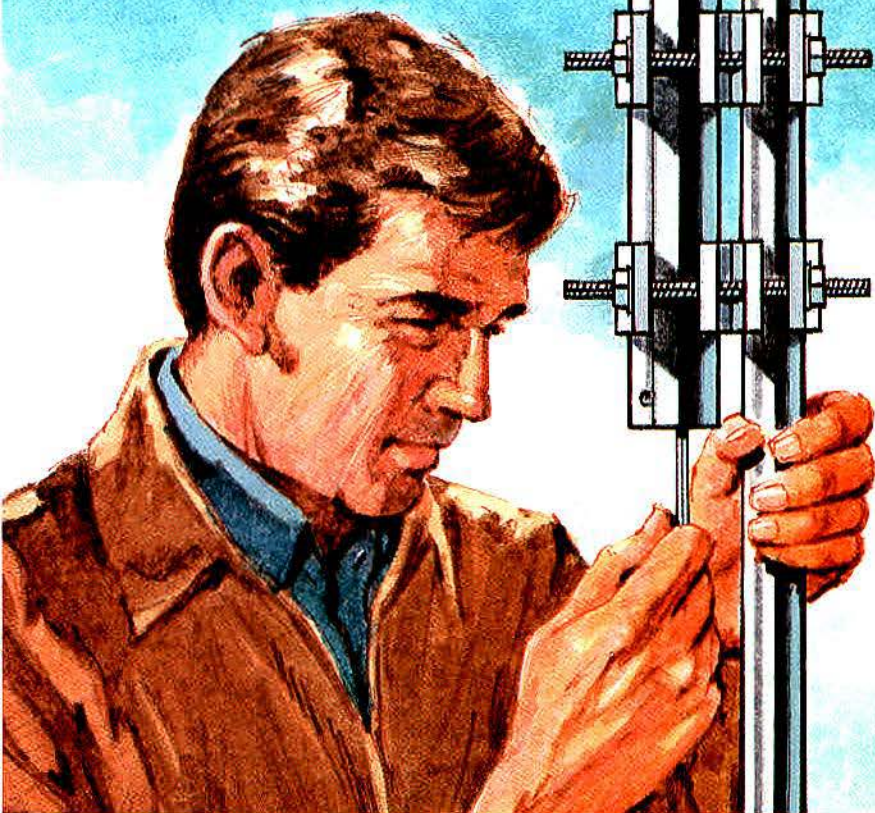
Signaling via modem

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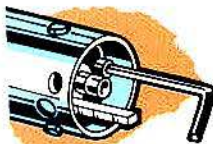
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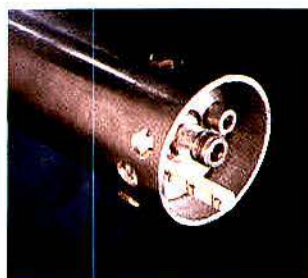
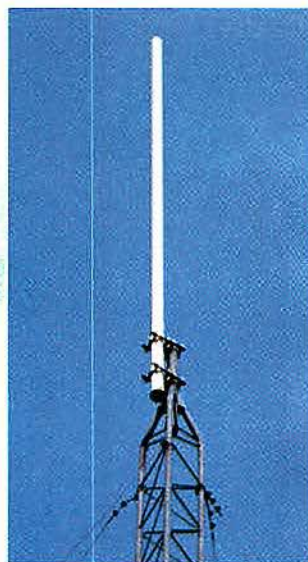


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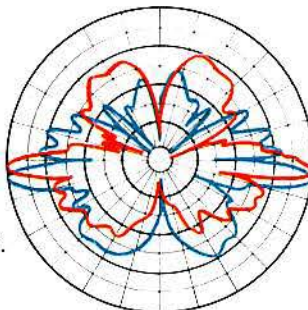


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The 10-site radio controller



Vega's C-5111 10-line/4-frequency console

Vega's Model C-5111 compact, easily rack-mounted, ten-line/four-frequency radio control console provides instant PTT, timed mute, and other most-needed features. This tone-format console allows you to quickly select one or any combination of up to 10 remote base stations. A second speaker allows you to monitor (with individual volume controls) any combination of those 10 stations that are not already selected for TX/RX control. Instant PTT switches allow immediate response to a call on a particular "selected" or "unselected" line, without disturbing the programming of the "selected" simulcast group or line.

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Circle (4) on Fast Fact Card

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Robert Lutz

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Dr. Rainald Schoneberg

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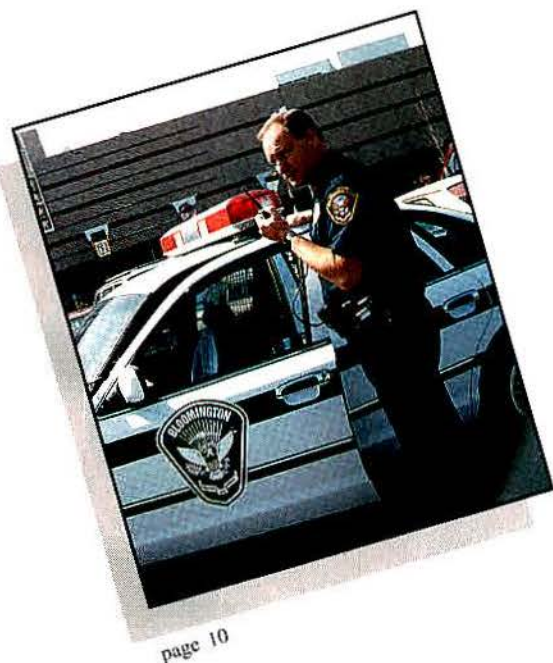
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page 26

AT LAST, MOBILE DATA & STATUS REPORTING AFFORDABLE FOR SMALLER FLEETS!



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Scanning . . .



Battery recycling

Multiplier Industries, Mt. Kisco, NY, has made it possible for customers to recycle any manufacturer's rechargeable nickel-cadmium (NiCd) two-way radio, cellular telephone and pager batteries.

As you may know, the cadmium contained in NiCd batteries should not be disposed of in trash destined for landfills.

At the same time, people who want to dispose of small quantities of NiCd batteries without introducing cadmium into the environment previously have had no place that we knew of to send them. Not even the largest retail companies that sell NiCd batteries to consumers seem to have programs for safe cadmium disposal or recycling.

Now once a month, customers can send NiCd batteries freight pre-paid (and \$1 per battery) to Multiplier for recycling. There is no minimum number of batteries that can be returned. Special arrangements can be made for large quantities.

Even though the program is limited because it is available only to the company's customers, it is a step in the right direction.

* * *

Ingenuity

Most experts about health risks connected with radio energy exposure have said that hand-held cellular phones are not hazardous to their us-

ers' health; nevertheless, a very small number of cellular subscribers apparently have stopped using hand-held phones—just in case.

Well, what should come along but a headset that allows people to continue to use hand-held phones and to put distance between their phones and their heads. The headset plugs into an adapter, and the adapter plugs into the hand-held phone. The headset is compatible with Motorola, NEC, OKI and Mitsubishi phones, among others.

When we learned about the headset on May 17, we thought this was another example of *American ingenuity* . . . of turning a *problem* into an *opportunity* . . . of taking a *lemon* and making *lemonade*.

OK, it may be ingenious, but as it happens, the product already had been in development for eight months, predating the cellular health scare episode that began Jan. 21 with a Larry King broadcast on CNN cable television.

Credit Andy Holman, Art Serrano and Al Blackford, the owners of Cellabs in Canoga Park, CA, for coming up with the idea.

Actually, Cellabs has made mobile and transportable cellular phone headsets for eight years. Seeing sales figures shift to the extent that hand-held phones make up as much as 80% of current cellular phone sales, the three

owners began developing headsets for the most popular type of cellular phone.

We don't know how much the potential headset sales will result from health considerations related to radio energy compared to safety considerations related to hand-held phone use in vehicles. Some customers may be motivated by the health factor.

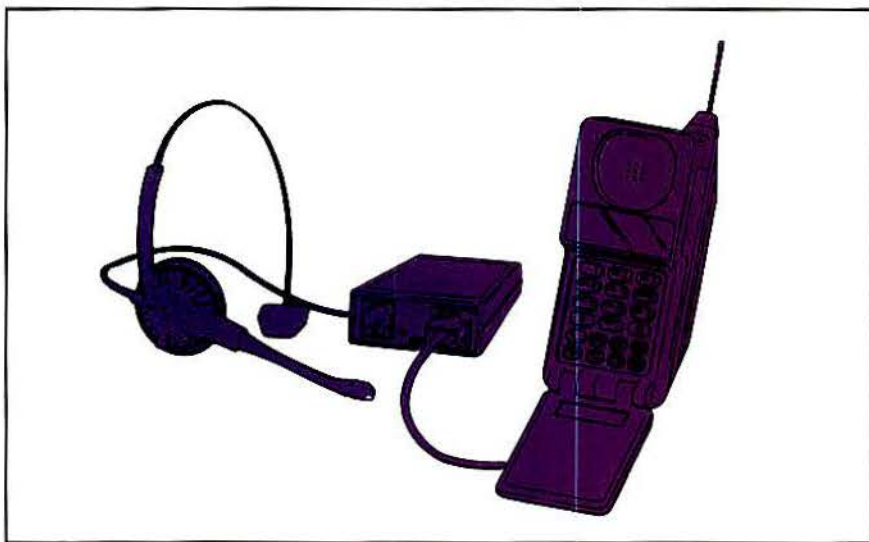
(With a headset, these phones become *hands-free hand-helds*, don't they? Advertising copywriters have handled tougher phrases than that, though.)

By the way, it is hard to find a worse position than horizontal on a car seat for a hand-held phone as far as making it difficult for a cell site to pick up signals is concerned. Wait—now there's a market for hand-held cellular phone *brackets* for cars! (...to hold the phone upright at window height for better reception.)

Or can you imagine connecting the hand-held phone to a headset *and* to an external antenna? (...the headset for safety; the external antenna for health and signal improvement.)

Safety and health are important considerations. Whether or not the use of a headset for portable cellular phones is thought to be important for health reasons by the experts, the *timing* for the product introduction just couldn't seem to be better.

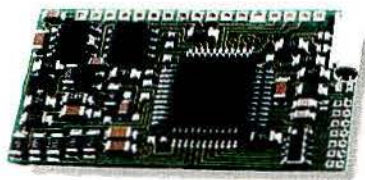
—Don Bishop



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July

- 18-22—**Forestry-Conservation Communications Association**, Jackson, WY. Contact: Don Pfohl, 602-644-3166.
24-28—**International Municipal Signal Association**, Norfolk, VA. Contact: Harold Glerum, 800-723-4672.

August

- 8-13—**Associated Public-Safety Communications Officers National Conference**, New Orleans Convention Center, New Orleans. Contact: 800-949-2726.

September

- 21-23—**International Mobile Communications Expo/Fall**, Philadelphia Convention Center, Philadelphia. Contact: 303-220-0600.
28-Oct. 1—**Mobile Communications Marketplace**, New Orleans Convention Center, New Orleans. Contact: Telocator, 800-326-8638.

October

- 12-13—**SMR/Private Carrier Management Conference**, Loews Coronado Hotel, San Diego, CA. Contact: 202-331-7773.

November

- 4-6—**Industrial Telecommunications Association**, La Quinta Hotel, La Quinta, CA. Contact: Barbara J. Levermann, 703-528-5115.
11-14—**Communications Marketing Conference**, Holiday Inn Riverwalk, San Antonio. Contact: Gene Johnson, Vega Signaling, 818-442-0782.
19—**Radio Club of America**, Communications Symposium and Annual Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.

1994

February

- 7-8—**AMTEX**, the American Mobile Telecommunications Association's

Marketing and Technology Conference and Exposition, Marriott on International Drive, Orlando, FL. Contact: 202-331-7773.

March

- 2-4—**Cellular Telecommunications Industry Association Winter Meeting and Exposition**, San Diego. Contact: 202-785-0081.
6-9—**Energy Telecommunications and Electrical Association**, Henry B. Gonzales Convention Center, San Antonio. Contact: 214-235-0655.

April

- 13-15—**International Mobile Communications Expo/Spring**, Las Vegas Convention Center, Las Vegas. Contact: 303-220-0600.

May

- 2-5—**Supercomm**, sponsored by USTA and TIA, and **International Conference on Communications**, sponsored by IEEE, New Orleans. Contact: USTA, 202-835-3100.
25-27—**RadioComm**, Vancouver Convention Center, Vancouver, British Columbia. Contact: Bill Eggertson, 613-233-4888.

June

- 7-11—**Vehicular Technology Conference**, sponsored by IEEE Vehicular Technology Society, Stockholm, Sweden. Contact: Professor Sven-Olof Ohrvik, technical chairman, 46 8 757 0483; Fax 46 8 34 8441.
18-23—**Utilities Telecommunications Council**, Washington Sheraton, Washington, DC. Contact: Rita Clark, 301-621-7802.

July

- 17-20—**Forestry-Conservation Communications Association**, Hershey, PA. Contact: Don Pfohl, 602-644-3166.

August

- 6-11—**International Municipal Signal Association**, Cavanaugh's Inn, Spokane, WA. Contact: Harold Glerum, 800-723-4672.



Mobile Radio Technology

The journal of mobile communications technology

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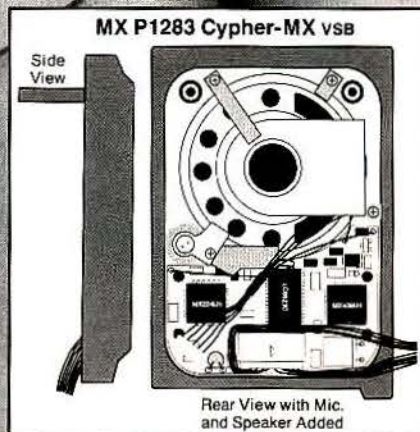
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Circle (7) on Fast Fact Card



Isolators—the practical view, part 2

By Harold Kinley, CET

In last month's column, some basic concepts of isolators were presented from a practical point of view.

This column includes some additional information about isolator use.

Input power vs. return loss

One isolator specification figure is input power rating.

If the reflected power is negligible (high return loss), then the isolator can be operated safely at full input power rating without exceeding its internal dissipation.

On the other hand, when the reflected power becomes significant, it increases the heating within the isolator and exceeds its maximum rated dissipation. To maintain a safety factor, the input power should be reduced to offset the increased dissipation caused by the reflected power.

Refer to Figure 1 above. Assume that both of the isolators shown in the figure are rated for 100W input power. The insertion loss is 0.35dB. The power input to isolator A is 100W (full

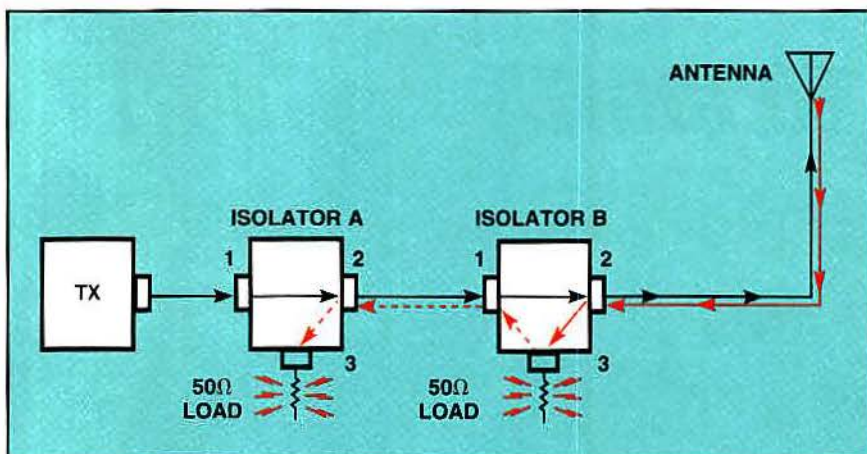


Figure 1. Two isolators can be connected in cascade to provide even greater isolation. The load resistor connected to port 3 of isolator B dissipates most of the power, shown in red.

rated power).

Because the insertion loss is 0.35dB, the output power at port 2 is 92.3W. Thus the power dissipated within the isolator is $100W - 92.3W = 7.7W$. To play it safe, 7.7W should be considered to be the isolator's maximum safe dissipation. As long as no reflected power enters the isolator and the input power does not exceed 100W, the in-

ternal dissipation will not exceed 7.7W.

When the load connected to the isolator output port is badly mismatched (low return loss, high VSWR), significant power is returned to port 2 and on to port 3 where it is "dumped" into the load. If the return loss is 3dB, for example ($VSWR = 5.85:1$), 50% of the output power from port 2 of the isolator reflects back into port 2 and travels to port 3 into the load.

In passing from port 2 to port 3, this reflected power causes increased dissipation within the isolator. If the isolator is operating at the 100W maximum input power, the output power from port 2 is 92.3W. The reflected power is 46.2W. The reflected power appearing at port 3 is 42.6W. The extra dissipation caused by the reflected power is $46.2W - 42.6W = 3.6W$.

Because of the reflected power, the isolator must dissipate $7.7W + 3.6W = 11.3W$. To bring the internal dissipation back to a safe level, the input power should be reduced to compensate for the reflected power.

(continued on page 50)

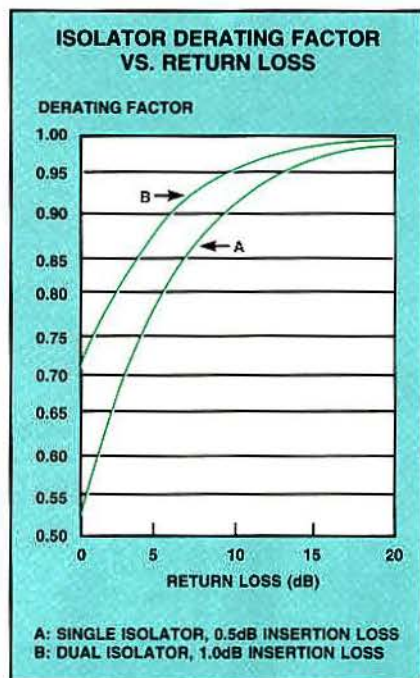


Figure 2. Use this graph to determine the derating factor to be applied to the input power for a given amount of return loss.

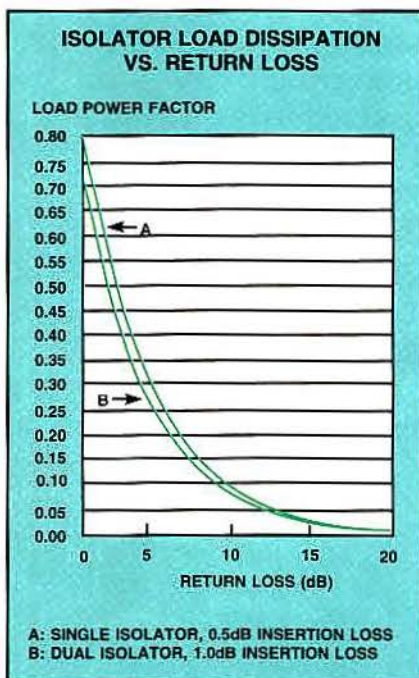


Figure 3. Use this graph to determine the required isolator load dissipation for a given amount of return loss.

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

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Minnesota city installs trunked radio system

In July 1992, the city of Bloomington, MN, implemented a digitally controlled trunked radio system that gives city agencies unprecedented communications capabilities and that delivers improved coverage.

By Robert Lutz

In 1988, the city of Bloomington, MN, Police Department radio system was inadequate.

Not only was it sometimes impossible for a supervisor in a squad car to monitor the activities of officers on patrol, but some parts of the city lacked radio coverage.

The radio system used two VHF frequencies sometimes configured as a repeater pair and sometimes configured as simplex channels, depending on need. Separating the frequencies as

simplex channels gained some operational flexibility yet sacrificed a lot of coverage.

When the repeater was in use, active patrol dispatch, detective and narcotics operations all vied for the same radio resource. This congestion resulted in uncontrolled, confusing and sometimes dangerous situations.

In addition, the RCA base stations and voting system were well beyond their useful life expectancy. For a city of 86,500 residents, the radio system was woefully deficient.

The police department's communications supervisor, Jean Guthery, was aware of the problems. She said that dispatchers were extremely busy trying to manage this crowded, two-channel operation.

Dispatchers were faced with a noisy

and complicated system that offered no way to separate pertinent dispatch traffic from ongoing investigations or special events.

Within the Public Works Department, according to Deputy Director Jim Gates, there were continual problems with channel congestion. Because Public Works shared its UHF channel with the Parks and Recreation Department, there were times, particularly in the summer, when users from both departments would attempt to use the channel simultaneously. The result was that neither had satisfactory access from an old RCA repeater system.

In addition, because Bloomington has many rolling hills and wooded areas, there were significant coverage problems for the old Public Works system.

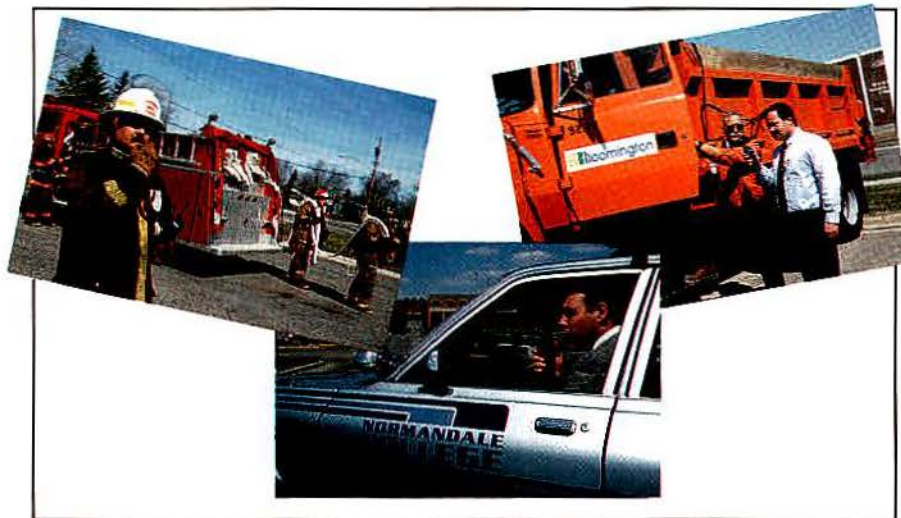
The Fire Department, which is staffed by 150 volunteers, faced similar headaches. According to Fire Chief Ullie Seal, the VHF repeater system offered no opportunity for separating fire ground operations except through a single statewide channel.

Worse yet, the repeater system had co-channel interference. Because of this interference, receivers had to be adjusted to limit their sensitivity to the point where in-building communications was next to impossible.

With all of these users having many of the same problems, something needed to be done. Efforts to license additional VHF frequencies were unsuccessful because in the Minneapolis-St. Paul metropolitan area, none were available.

At about this same time, there was

Lutz is a 25-year law enforcement veteran who spent 20 years with the city of Minneapolis before joining the city of Bloomington, MN, Police Department in September 1988 as chief.



Various city administrative and agency employees, including Public Works Department and Fire Department employees, as well as security officers from Normandale Community College, can communicate directly with one another via radio.

Take A Look At Our Brass

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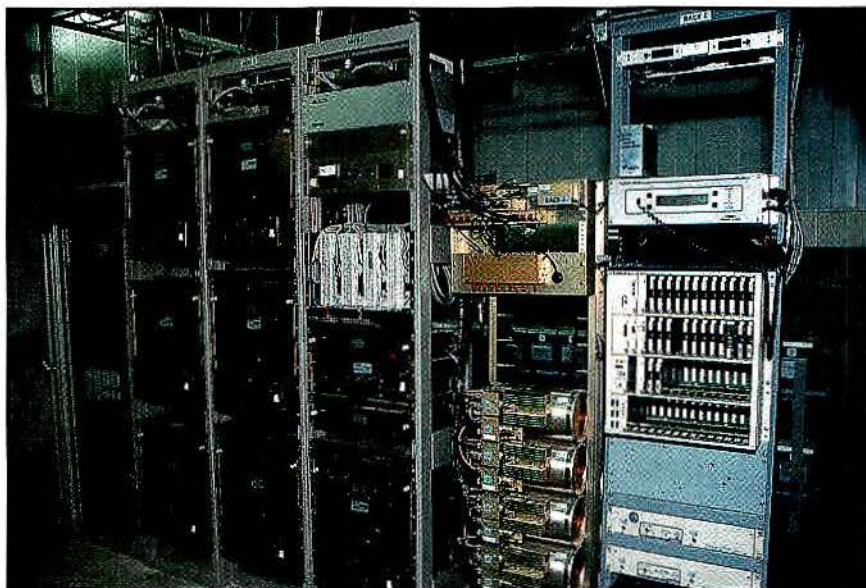
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The equipment room at the primary transmit site, Norwest Financial Center, includes (far left rack) the site controller and system diagnostic equipment; (next three racks) the seven base station transmitters for the 7-channel trunked radio system; and (right two racks) the combiners, filters and microwave radio equipment.

talk among neighboring communities about 800MHz trunked radio technology. Three manufacturers gave the city information about their trunked radio systems. City representatives attended seminars and presentations about

800MHz trunked radio and decided to investigate it seriously.

A plan develops

In early 1989, Police Captain Richard Porth was assigned to manage a

study of radio system options.

Leonard J. Koehn and Associates consulting engineers of Woodbury, MN, was contracted to assist, and the work of evaluating the current system, present and future user requirements and 800MHz trunked technology began.

Following months of study, Capt. Porth, Chief Seal and Koehn visited radio systems and vendor facilities in California, Florida, Illinois, Minnesota, Wisconsin, and Virginia and returned with ideas about which features and design characteristics were important.

The system is constructed

Based on the city's requirements and

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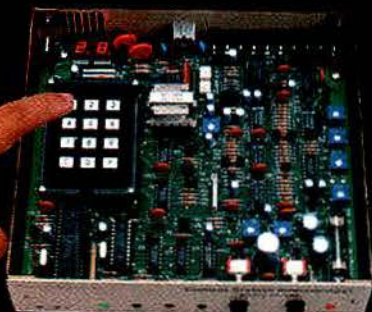
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The RT8 system is used to put ordinary tone or pulse telephones in locations where wire service is not available. **\$299.00 dealer net.**

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the capabilities of various vendors' systems, Koehnen assembled a *Request for Proposal* that was released to potential bidders in early 1991. In June 1991, a contract was awarded to Ericsson GE Mobile Communications (EGE) for its enhanced digital access communications system (EDACS) trunked radio system.

As project administrator, Capt. Porth

communicated almost daily with the EGE representatives. Ken Ballard was assigned as EGE's project manager; he coordinated the activities of the site manager, Dennis Esterly and the prime installation subcontractor Steve Harmon of Two Way Communications Company, Eau Claire, WI.

For the next 12 months, Capt. Porth, Ballard, Harmon, and Koehnen practi-

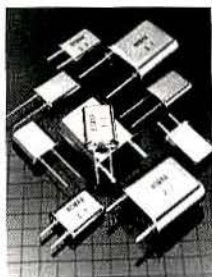
cally lived and breathed the Bloomington system. They participated in the factory testing and staging process at EGE's Lynchburg, VA, headquarters, and along with Esterly, they were involved in nearly every aspect of coordinating the system installation.

System design

The Bloomington system uses a single-transmit, four-receive system design.

The 24-story Norwest Financial Center near the center of the city's northern boundary, provides a 348-foot high vantage point for antennas. Seven 800MHz repeaters are at this site, along with the site controller computer, sys-

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The 24-story Norwest Financial Center near the center of the city's northern boundary, provides a 348-foot high vantage point for antennas.

tem diagnostic subsystems and microwave equipment.

A backup transmitter site is located at a water tank in the northwest corner of the city, and additional receive-only sites are located at an office building on the eastern edge of the city and at the new Communications Center located at City Hall in the south-central part of the city.

The Communications Center is connected with the other three sites with 18GHz digital microwave links. Analog and digital voting comparators for each channel are at the Communications Center.

Each repeater contains a trunking card with a microprocessor. This distributive processing implements a failsoft design that can take over trunking control functions if the main site controller computer ever fails.

Concurrent with the installation of the trunked system, the Public Works Utility Division awarded a contract to

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CES



The new Communications Center in City Hall includes new radio dispatch consoles.

Autocon Industries of St. Paul to supply a supervisory control and data acquisition (SCADA) system to control and monitor the city's fresh, waste and storm water facilities.

Autocon engineers worked with their counterparts at EGE and imple-

mented a system with 42 remote terminal units that use the 800MHz trunked system to carry telemetry. The combination gives city employees complete and immediate control of remote pump stations, elevated tanks and other metering locations.

In conjunction with the radio system, a new public safety dispatch center was designed and constructed. The dispatchers had long toiled in a less-than-desirable environment. Along with a new computer-aided dispatch (CAD) system, the city acquired four cathode-ray tube (CRT) based EGE Maestro dispatch console positions. The technology, features and flexibility of the CRT console represents a quantum leap forward from the previous hard-wired, dedicated modular console.

A primary reason for the city's selection of the 800MHz system it chose is the system's ability to support current analog and future digital transmission requirements.

Without additional equipment, the system can handle the vendor's digital voice system as well as pure data applications such as the SCADA system. The 800MHz system provides a platform for any conceivable future requirement, including the transfer of the current mobile data system from

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800MHz conventional (non-trunked) radio to trunked radio and for advanced technologies such as Global Positioning System (GPS) based vehicle location.

Talk group flexibility

On July 28, 1992, the Bloomington trunking project reached a milestone when the system was turned on and the

transition to trunking began.

It was a baptism under fire because the switch to the trunked system happened at almost the same time that the Mall of America, the largest shopping mall in the United States, opened on Aug. 9.

With more than 130,000 visitors per day, the mall draws visitors from all over the world. Traffic control and

support of mall security activities has proven to be a major challenge for the Bloomington Police Department.

Without the flexibility and coverage provided by its new 800MHz radio system, the city could not have begun to provide the level of service required as a result of the mall development. Trying to manage with the old system would have meant providing less-than-adequate service to the mall's visitors and to Bloomington's citizens.

Having the ability to configure the radio system to meet operational needs instead of the other way around takes getting used to.

The Police Department has adapted quickly to the possibilities of setting up special event details on tactical talk groups. Long-running police investiga-

*When shooting began
and an officer was
wounded, he was able to
communicate his status
immediately . . .*

tions and special details can be assigned to their own talk groups without reducing the system balance.

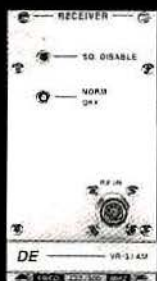
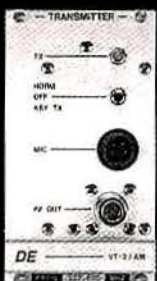
For example, when the special weapons attack team (SWAT) responded to a hostage-taking, the SWAT officers, along with entry and gas delivery teams, had the critical, up-to-the-minute information they needed. When shooting began and an officer was wounded, he was able to communicate his status immediately, and paramedics were coordinated to come to his aid. A serious incident was contained, thanks in no small part to the new radio system.

Fire Chief Seal said he enjoys the flexibility he has in establishing multiple fire ground talk groups.

From a single radio, fire department units can communicate with each other and, alternately, with neighboring agencies via the specially equipped state fire mutual aid patch. Communi-

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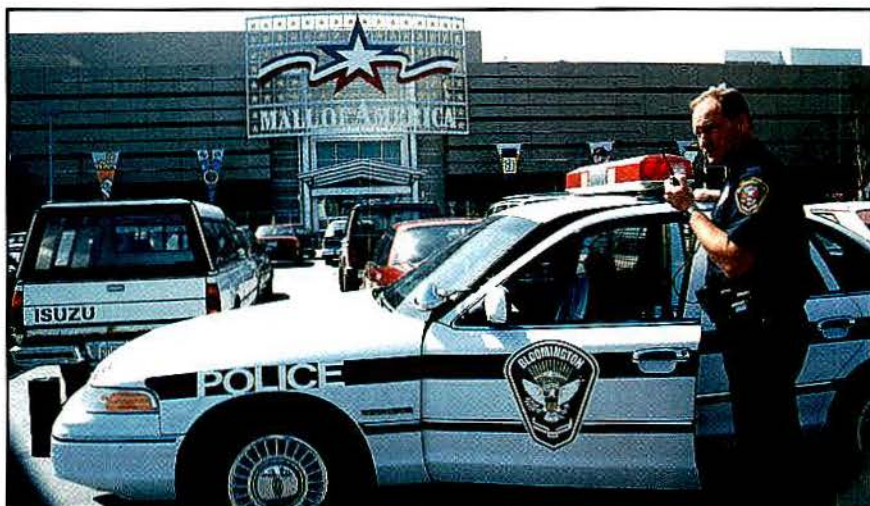
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Bloomington police officers using the EGE system can communicate directly with Mall of America security officers using their Motorola system.

cations between fire department and police units on the scene of a fire take place on a tactical talk group in a way which was never before possible.

Communications Supervisor Guthery said that sometimes dispatchers forget the full possibilities of the

system.

She said that during an ice storm, a dispatcher took a request for a sanding vehicle from a police patrol unit and passed it on to a public works unit before remembering that the two employees now can communicate with-

out dispatcher intervention.

The dispatchers' confidence in the new system is high. They have adapted quickly to the new technology, and they know that when they speak, they are being heard. The days of trying to sort out important dispatch traffic from unrelated activities are past.

Deputy Director Gates of Public Works said that a key benefit is the ability for his employees to talk with their counterparts in other departments.

For example, with the "city common" talk groups that every radio contains, a police unit can speak with a public works night crew directly about a fallen tree, instead of requesting that the dispatcher telephone a foreman at home to request help.

A fire crew can request a road block from the Public Works Department through direct radio communication.

In addition, Gates points out that all radio traffic heard within talk groups is pertinent; there is no more radio interference among employees working on unrelated projects.

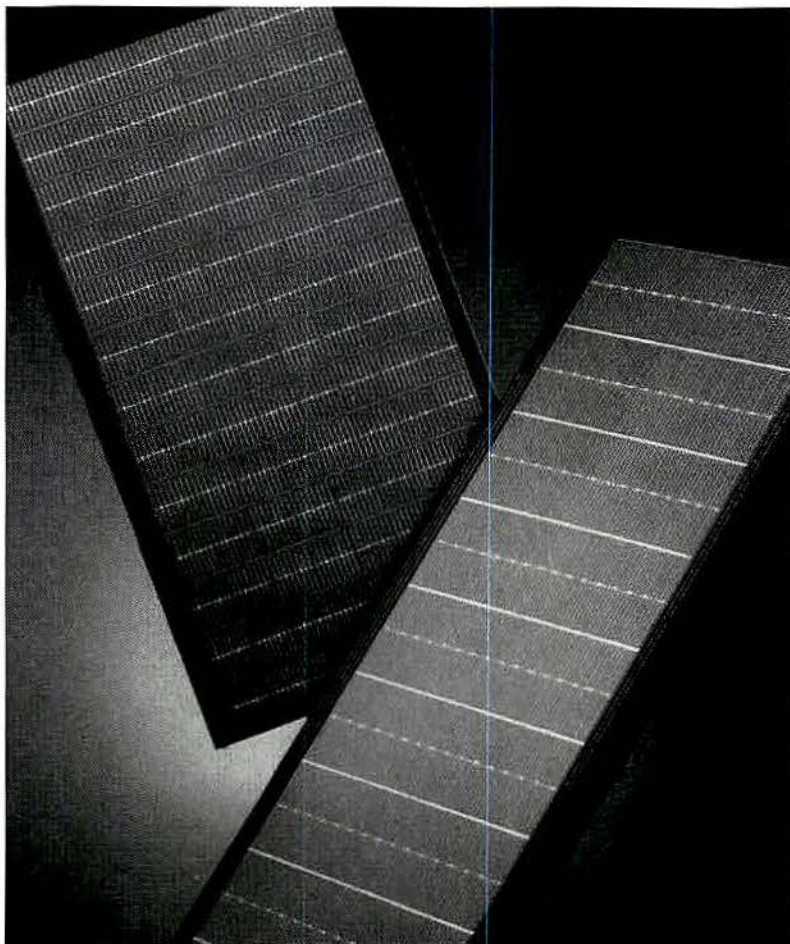
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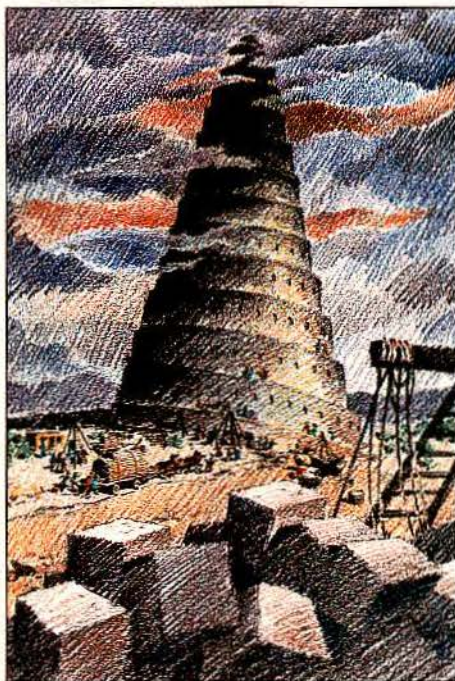
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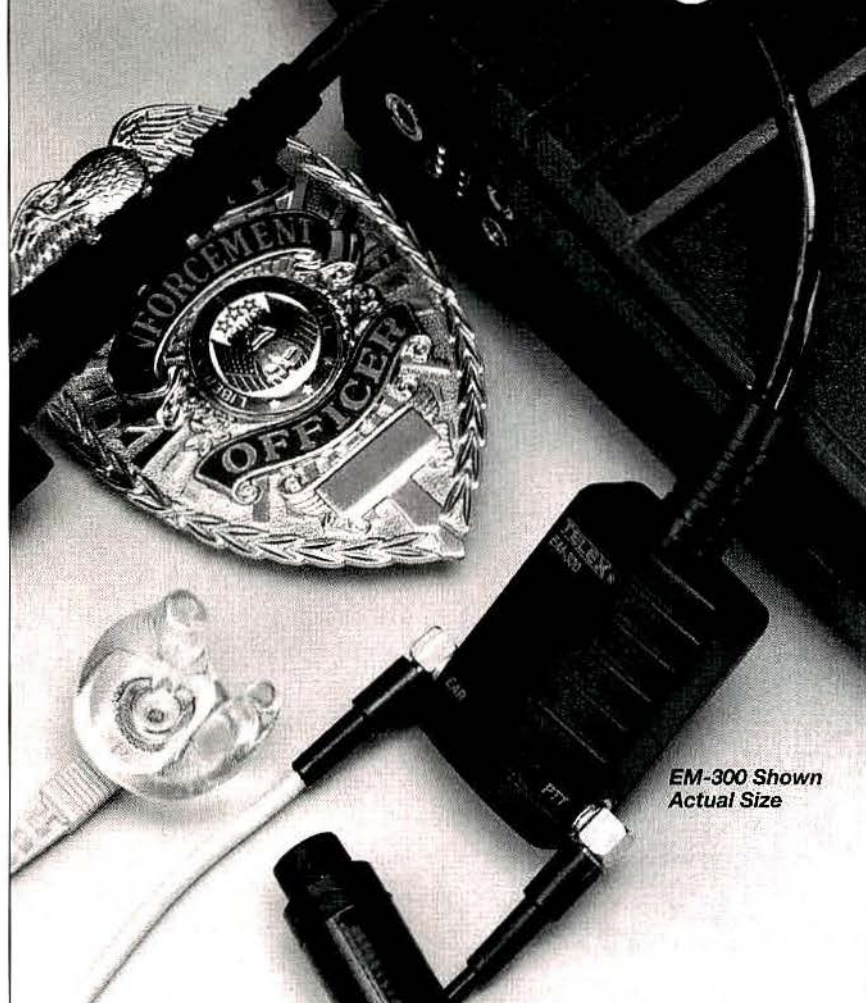
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TELEX

As the city planned the trunked system design, a key consideration was that the city could not become a frequency or signaling protocol island.

Operating on 800MHz might have meant isolating the city from its neighbors that continue to use VHF systems. Moreover, the EGE system uses protocols that differ from those in the Motorola trunked system at the Mall of America and the E.F. Johnson trunked system used by the city of Eden Prairie to the west.

To sustain radio communications with other jurisdictions, the system includes "patch options."

The *conventional interface* (CI) or *console patch* is established by the

As the city planned the trunked system design, a key consideration was that the city could not become a frequency or signaling protocol island.

dispatcher between the Bloomington "PD Coordination" talk group and the Mall of America Security "Red Channel" to allow Bloomington police officers with EGE radios to communicate with mall security employees with Motorola radios. Additional CI patches can be set up, as required, to allow radio communication with Eden Prairie and other VHF and UHF networks.

Automatic or hard patches that use a *conventional network interface* (CNI) always are operational and available to police and fire units without dispatcher intervention.

A CNI patch to the VHF (155.475MHz) state law enforcement mutual aid frequency (MINSEF) automatically rebroadcasts MINSEF traffic on the corresponding Bloomington police MINSEF *talk group*. With this automatic patch, Bloomington officers can communicate with neighboring police agencies and the Minnesota State Patrol by radio.



ANTENNA CATALOG

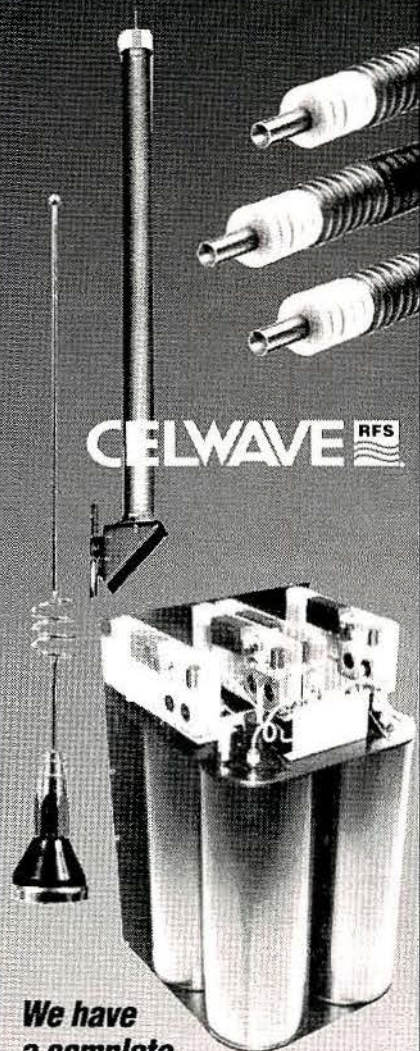
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Additional CNI patches allow communications with county emergency and state fire mutual aid networks. These patches operate differently than MINSEF because they are *on-demand patches*. No traffic on these VHF channels is patched into the trunked system unless a trunked system user first transmits over that particular talk group. The patch is reset to an idle mode when all users have returned to another talk group. This sophisticated patching assures efficient use of the trunked system channels.

In a slightly different CNI application, the VHF (154MHz) Fire Department paging system is patched to the *fire dispatch trunked talk group*. This connection allows fire fighters to receive trunked dispatch and first-responder 800MHz traffic over their VHF monitor pagers.

In addition to these patch capabilities, every police and fire department radio is programmed with the five 800MHz National Public Safety Planning Advisory Committee (NPSPAC) mutual aid channels. Although there presently are no fixed stations in the area to support these channels, current 800MHz users can use the channels to communicate in a *talkaround* or *car-to-car* mode (simplex radio).

When it comes to radio communications, the city of Bloomington is not an island.

When it comes to radio communications, the city of Bloomington is not an island.

Conclusions

When the city began to plan for a replacement radio system, it was envisioned that an 800MHz trunked system would solve many of the problems in the existing public safety radio systems and provide a citywide system for use by all departments.

The resulting system exceeds the expectations of everyone involved with the project. Radio communication is possible in every corner of the city and in areas far beyond what was predicted.

Users who travel throughout the Minneapolis-St. Paul metropolitan area, which is beyond Bloomington's normal service area, regularly experience reliable coverage with portable radios.

Radio communication is no longer an issue. Previously, one could count on radio system problems being talked about at staff meetings. Today, no one mentions radios at staff meetings. Users who previously were concerned about their ability to communicate effectively have total confidence in their radio system today.

The capacity that results from the transmission trunked format is almost unbelievable. A lot of time was spent studying the impacts of system priorities and queuing, and the fact is that, with more than 500 voice users and

more than 40 data-only SCADA radios operating around the clock, there have been no system busy periods.

The city is actively seeking participation from neighboring

agencies, based on the performance and capacity of its new system.

The city is in the final stages of system acceptance testing.

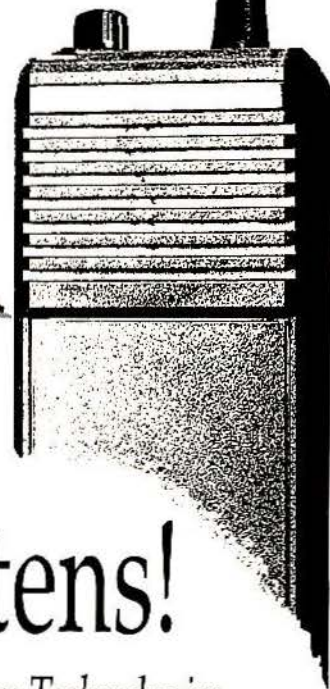
The 800MHz trunked system has offered the city the greatest possible value as evidenced by the CNI interfaces to conventional and other trunked systems and by the ability to integrate the SCADA system without another costly stand-alone radio system.

Users from the police, fire, public works, utilities, and park and recreation departments, along with city administrative employees and security officers from Normandale Community College, share a single radio system that provides performance and the opportunity for interdepartmental communications only dreamed of in the past.

Radio communication is possible in every corner of the city and in areas far beyond what was predicted.

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By Dr. Rainald Schoneberg

Today's computer language is zeros and ones: Letters, numbers and even pictures are represented by strings of these two basic units, called *bits*.

A letter can be identified by a string of eight bits. A picture normally requires a string of millions of bits.

Data communication deals with transferring zeros and ones from one computing device to another. This communication may be from a per-

sonal computer (PC) to a printer, from an automatic teller machine (ATM) to a bank's mainframe computer or from a pressure sensor to a control unit.

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Ten zeros and ones are sequentially transmitted for each character: a start bit, eight data bits and a stop bit. Transmission and reception speeds are selectable from 75 bits per second (bps) to 19,200 bps. Hence, as many as 1,920 characters per second (cps) can be exchanged each way.

Modems are the mainstay of the *remote* data communication industry.

They are required to convert data to audio and back again. Each successive modem generation offers an impressive array of new bells and whistles. Speeds greater than 50,000 bps are advertised.

Data compression

In reality, 2,400 bps and 9,600 bps modems dominate.

Faster transmissions are achieved through data compression. A text of 2,000 letters is reduced, for example,

to 800 characters by eliminating redundancies, and only those 800 characters, which represent instructions and letters, are transmitted. The gain in speed is achieved by software programs simple enough for many high school seniors to write.

Synchronization

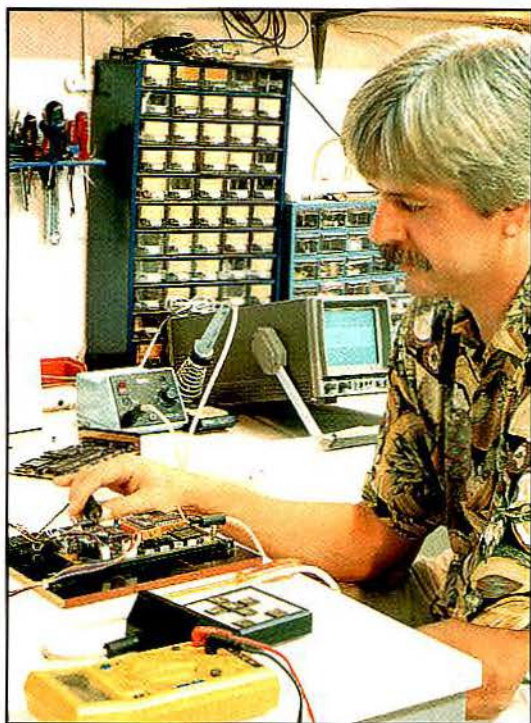
Why does it usually take at least one minute to send a page of text from one facsimile machine to another?

The answer is *synchronization*. Before a modem (built into a fax machine) actually transmits data, it has to negotiate format and speed with the receiving modem and get the timing right. This process is an *overhead* that reduces the effective speed, a fact that often is omitted from advertisements that include modem speed figures.

Asynchronous

Many modem uses are *question and answer*.

For example, a corporate database is interrogated, and the information is displayed, or a purchase with a credit card is submitted and authorized. Relatively few zeros and ones have to be transmitted each way. The modem overhead makes it, nonetheless, a time-consuming effort.



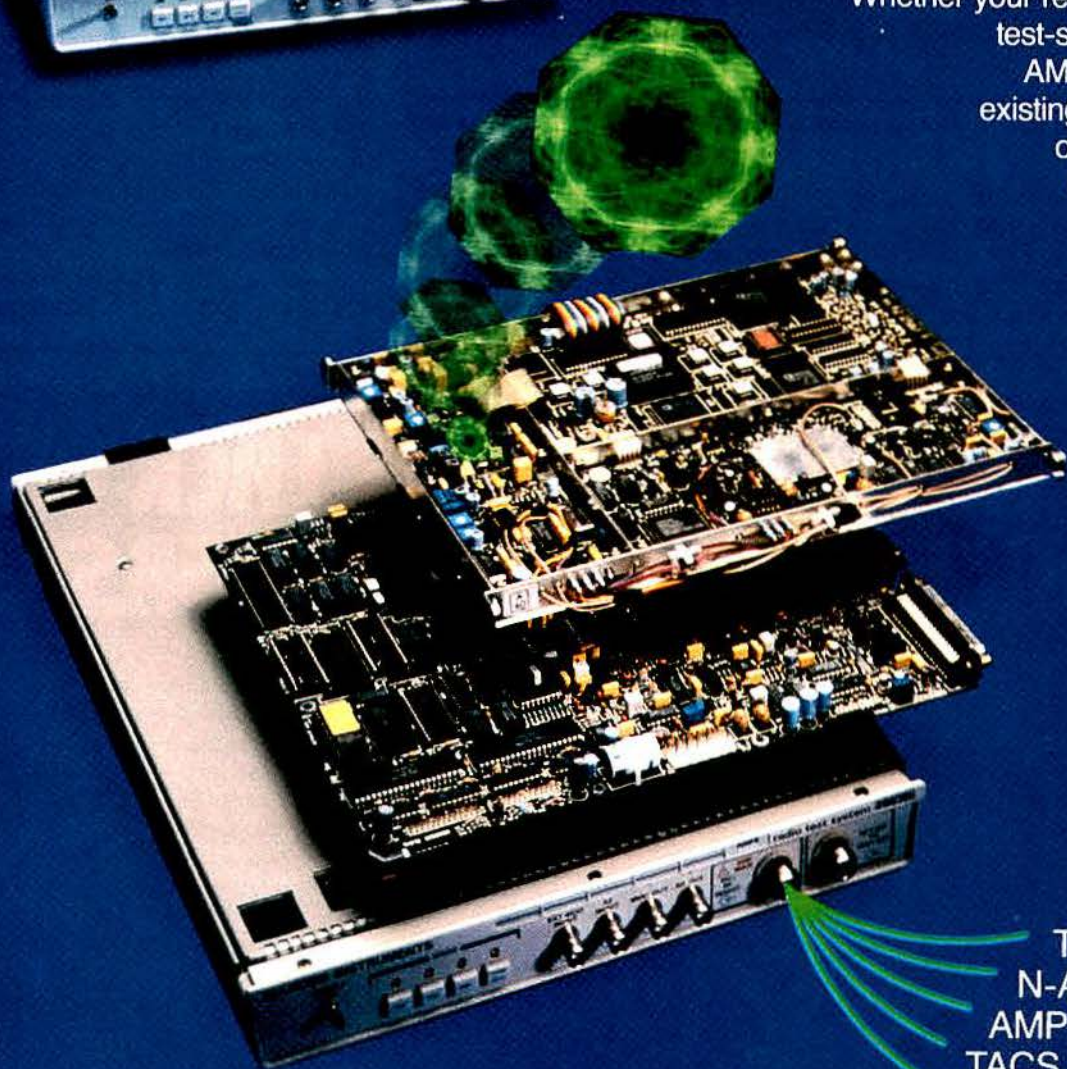
The author uses a computer to program the prototype modem for use with off-the-shelf radio communications equipment.

Schoneberg is head of research and development at Comacs Enterprises, Orlando, FL. He earned M.Sc. and Ph.D. degrees in mathematics from the Technical University of Aachen, Germany. A prototype modem built according to Schoneberg's patent is used as an example in this article, which was printed in the May 1993 issue of *Proceedings of the Radio Club of America*.

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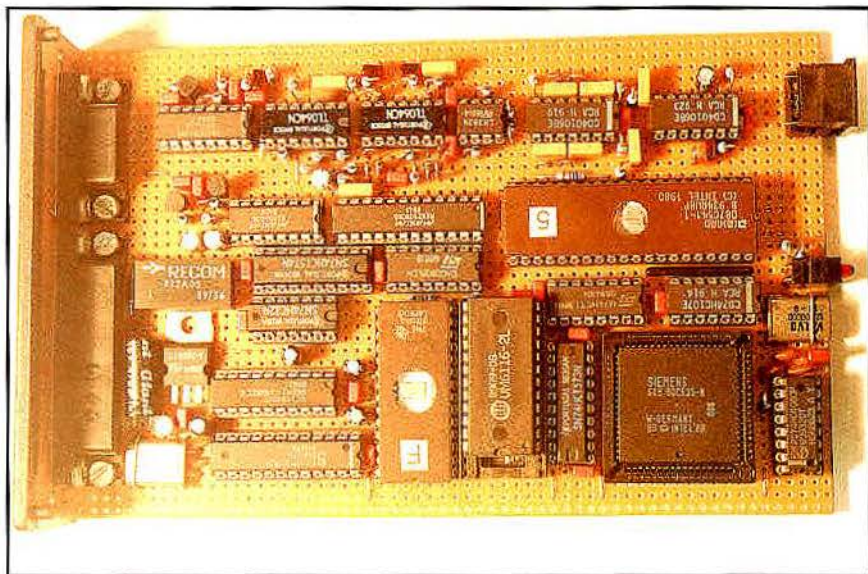
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This prototype of the new modem was used in tests with various HF, VHF and UHF transmitters.

Such bursty data traffic calls for asynchronous modems with little or no overhead. In fact, one of the earliest modem technologies, frequency-shift keying (FSK), provides just that.

A zero is encoded into one frequency and a one encoded into another frequency. A certain frequency at a certain time thus corresponds precisely with a zero or a one. Characters are

transmitted using start and stop bits. The ideal solution? Not quite!

Problems occur when switching from one frequency to the other. Traditional frequency detectors need a considerable amount of time to complete their work. Hence, modems based on FSK and related techniques never got beyond the 2,400 bps barrier. That is, at most, 240 characters transmitted per second.

Transmission paths

Voiceband channels (such as telephone and radio) are the vehicles of remote data communication.

Their characteristics historically grew to accommodate audio and to make best use of the resources (cables and frequency bands); therefore, they transmit only a certain range of tones (frequencies) and change the volumes (amplitudes). The volume normally is affected differently for different tones (amplitude response).

Finally, something called *phase* usually is changed along a transmission

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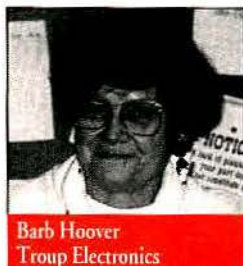
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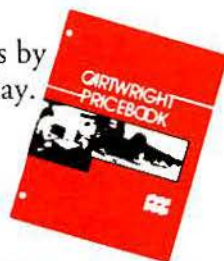
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path. These phases of tones can be viewed as a *timing*. They are irrelevant for voice communications. A trained ear may, nevertheless, recognize when two instruments are *out of phase*.

The effects on frequencies, amplitudes and phases of any given voiceband channel pose difficulties for data communication because data are transmitted by manipulating a fre-

quency, an amplitude, a phase or a combination of two or all three, as fast as possible.

Of the three, frequency usually is least affected (distorted). If the musical tone A (a 440Hz audio frequency) were transmitted, chances are extremely high that the tone A would be heard at the receiving end.

Phases and amplitudes do not re-

main as undistorted by transmission as frequencies. Telephone and radio amplifiers, repeaters, switch boards and satellite links sometimes cause severe and unpredictable results.

Fax machines incorporate modems that manipulate phases and amplitudes and, therefore, are quite busy generating an acceptable speed for their task.

Nyquist and Shannon rules

Audio signals, which are composed of different tones of varying volumes with individual timing, are changed by voiceband channels.

Long before the term *computer* was coined, scientists discovered rules that explain those changes. From those discoveries, basic limits for *working* remote data communication procedures can be deduced.

For radio or telephone channels two of the most notable ones are:

If manipulations of an audio signal in response to data are executed at time intervals of fixed duration, then (1) this duration must be at least 1/3000 of a second (*Nyquist rule* [bandwidth]) and (2) the total number of different manipulations must not exceed 40 (*Shannon rule* [signal-to-noise ratio]).

Because 40 different manipulations can represent any combination of five zeros and ones (2 to the 5th power is 32), the maximum working speed is hence $5 \times 3,000 = 15,000$ bps. So how can manufacturers promise more? Software-based enhancements yield the added throughput.

The problems that advanced data communications must overcome are the "known" limits and the high potential for phase and amplitude distortion.

A new approach first must refrain from manipulating audio signals at fixed time intervals. This approach also would facilitate asynchronous data communication, which is not properly served today.

Second, a new approach should rely on tones and refrain from allowing phases and amplitudes to carry information.

Getting 'AHEAD'

Tones are used with FSK.

The duration of each tone is fixed—hence the term *keying*. The well-known Morse approach to information



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P450VDA, P460VDA	450-460, 460-470	<1.2	16	-20	Bipolar	\$ 74.95
P450VDG, P460VDG	450-460, 460-470	<0.5	16	+12	GaAsFET	\$109.95
P800VDG, P830VDG, P860VDG	800-830, 830-860, 860-890	<0.6	19	+12	GaAsFET	\$119.95
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SP30VDG, SP35VDG, SP40VDG, SP45VDG	30-35, 35-40, 40-45, 45-50	<0.55	26	+12	GaAsFET	\$139.95
SP150VD, SP160VD, SP170VD	150-160, 160-170, 170-180	<1.6	15	0	DGFET	\$ 74.95
SP150VDA, SP160VDA, SP170VDA	150-160, 160-170, 170-180	<1.2	15	0	DGFET	\$ 86.95
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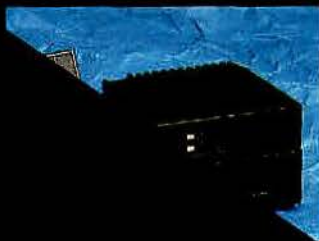
FUJI RDP



SL-11R [black]



SL-11R [dark gray]



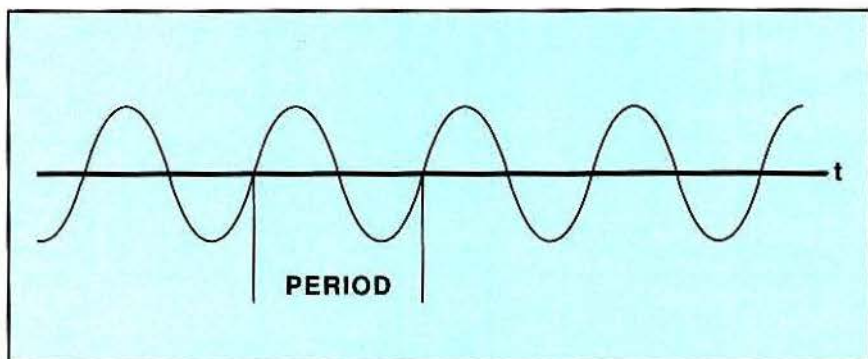


Figure 1. In the *time domain*, a frequency is represented by its *period*, which is the duration of a fullwave.

transmission uses different durations of one tone. Can different tone durations and tone frequencies be combined in a signaling format?

All tones that can be transmitted over a given voiceband channel are, when phase and amplitude are of no concern, fully determined by their frequency.

In the *time domain*, a frequency is represented by its *period*, which is the duration of a fullwave. (See Figure 1

above.) A tone is generated by repeating this fullwave over and over. For example, the musical tone A is based on a fullwave of duration 2,273 microseconds ($1,000,000/440 = 2,273$).

To use tones for data encoding, at least two must be selected. By way of example, these can be 2,500Hz and 3,125Hz tones, which usually can be transmitted satisfactorily over any voiceband channel.

The period of the 2,500Hz tone is 400 microseconds; the period of the 3,125Hz tone is 320 microseconds.

If the binary digital value of 1 is assigned to the 2,500Hz tone and the binary digital value of 0 to the 3,125Hz tone, the data encoding is defined.

A stream of zeros and ones then is translated into consecutive fullwaves of the two frequencies. This assembly of tones may be transmitted over any voiceband channel.

At the receiving end, though, the assembly of tones is distorted. In particular, tones of different frequencies travel along a transmission path at different speeds (group delay).

Hence, the fullwaves of different frequencies arrive with different delays, causing interference. One fullwave gets into the *time domain* of the other.

This phenomenon, called *inter-symbol interference*, complicates procedures. So how can the information the audio signal contains be recovered at the receiving end?

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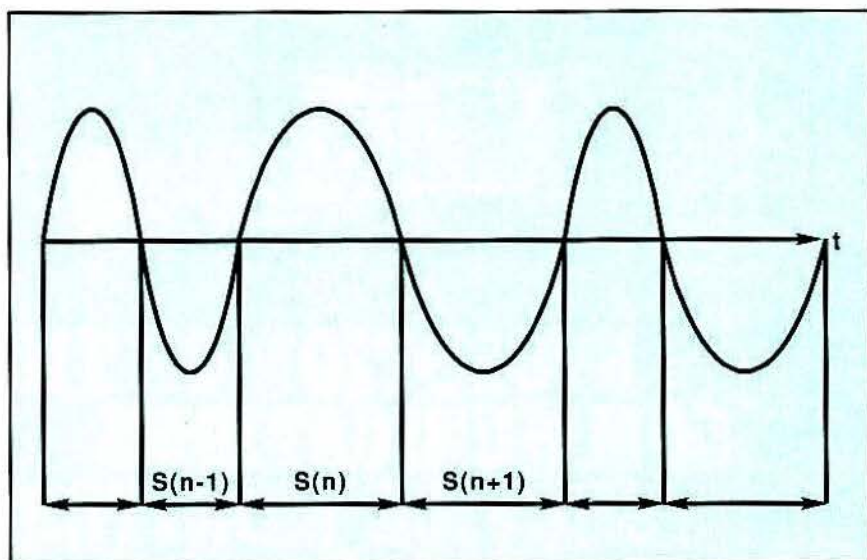


Figure 2. A 1 is encoded into a halfwave 200 microseconds long and a 0 into a halfwave 160 microseconds long.

Traditional FSK simply sends more than one fullwave of a tone for each bit, thus slowing the speed considerably. To increase the speed, sending more than one fullwave of a tone per

bit must be avoided.

So-called *adaptive* equalizers are required to reverse the intersymbol interference. These equalizers are used in almost all higher-speed modems

today. They require frequent automatic tuning, thus expanding the data transmission overhead.

A better approach is not to *eliminate* but to *account for* the interference. To this end, certain channel effects have to be quantified.

Recall that, in this context, a fullwave of a tone is defined by its period, which is the elapsed time between one zero crossing and the second zero crossing to follow. This elapsed time fully represents the bit information at the transmitting end.

In the example, a 1 is represented by 400 microseconds and a 0 is represented by 320 microseconds. On the receiving end, it always is possible to reverse at least part of the encoding process. In fact, measuring the elapsed time between one zero crossing and a following zero crossing of an audio signal is a rather simple and standard textbook exercise. A sequence of elapsed time measurements thus can be derived easily at the receiving end.

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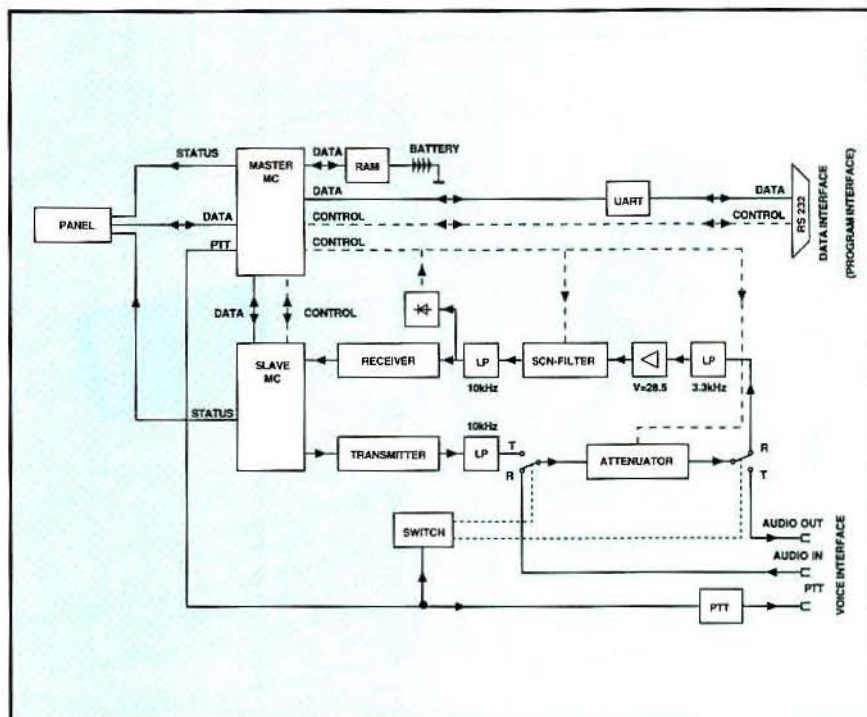


Figure 3. This is the block diagram of a prototype modem design that has been tested over telephone systems in Europe and North America. The same design was used in conjunction with HF, VHF and UHF radio equipment with excellent results.

ferent from the sequence used at the transmitting end, but it is not random either. An invention documented with the U.S. patent 5,103,463 of April 7, 1992, shows that most, if not all, voiceband channels follow a certain pattern.

To be more precise, characteristics of a voiceband channel allow exact prediction of the elapsed time duration sequence at the receiving end. A mathematical model of the channel effects can be formulated and used to calculate the receive sequence using the transmit sequence. This holds the key to useful applications.

Before going into detail, the sample data encoding may be modified to employ halfwaves instead of fullwaves, thus gaining speed. A 1 is encoded into a halfwave of length 200 microseconds (which is half the fullwave of frequency 2,500Hz) and a 0 into a halfwave of 160 microseconds.

These halfwaves can be assembled similarly to the fullwaves to form an audio signal because the polarity

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(phase) does not carry any information. (See Figure 2 on page 34.) Then, every 200 microseconds, at least one bit is encoded, resulting in a speed of 5,000 bps or higher.

Encoding a stream of zeros and ones results in an audio signal of halfwaves with frequencies switched at zero crossings between 2,500Hz and 3,125Hz. Such an audio signal is fully

determined by a transmit sequence $S(1), S(2), \dots, S(n-1), S(n), S(n+1), \dots$, where the $S(i)$ are either 160 microseconds or 200 microseconds, depending on the corresponding bit value.

At the receiving end, a sequence $E(1), E(2), \dots, E(m), \dots$ can be determined by measuring the elapsed time between two consecutive zero

crossings. This sequence is—according to the invention—in the simplest case, related to the transmit sequence by the formula:

$$E(m) = A*S(n-1) + B*S(n) + C*S(n+1)$$

where

A, B and C are positive constants with $A + B + C = 1$.

If, for example, $A = 0.2$, and $C = 0.3$, then the sub-stream. . . , 0, 1, 1, 0, . . . of bits generates a transmit sub-sequence. . . , 160, 200, 200, 160, . . . and results in a receive subsequence of . . . , 192, 188, . . . , because $0.2*160 + 0.5*200 + 0.3*200 = 192$ and $0.2*200 + 0.5*200 + 0.3*160 = 188$.

Once the coefficients A, B and C are sufficiently known, the recovery of data at the receiving end is possible. The measured receive sequence of elapsed time durations is compared to all possible transmit sequences via the above formula, and the transmit sequence generating the best match is considered to have been used at the transmitting end.

Finding or adapting the coefficients A, B and C is easy.

Experimenting with empirical sets yields excellent estimates in a short time which are usable during extended lengths of time for whole groups of voiceband channels and transceivers, such as radios and telephones.

Staying 'AHEAD'

This new technology has been named *AHEAD*, an acronym for *asynchronous halfwave encoding and decoding*.

It bypasses the limits of the Nyquist and Shannon rules by avoiding audio signal manipulations at fixed time intervals (frequency domain approach). Instead, it assembles halfwaves chronologically in response to data without a signaling rate (time domain approach).

The decoding does not eliminate intersymbol interference but takes it into account. Channel effects are quantified and the data is recovered by using neighboring, past and future

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Trunking Repeater
Manager



If you're thinking about upgrading your LTR® trunking system or building a new one, consider the advanced features and practical capabilities that a Model 49 will provide at a minimal cost. Zetron's LTR Controller provides LTR logic, interconnect (RIC), validator, airtime accumulator, and built-in modem -- all in one package!

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Circle (36) on Fast Fact Card

halfwaves to explain present halfwaves at the receiving end.

To turn AHEAD, as explained so far, into a complete modem, a certain *start signaling* is required. Naturally, halfwaves come to mind. Selecting a third frequency (for example, 2,083Hz, with a halfwave time duration of 240 microseconds) gives an easy solution.

Each encoded character (composed of eight bits) is preceded by a 480-microsecond-period fullwave (which is equal to two halfwaves with durations of 240 microseconds). This preamble allows the receiver to detect and decode a character simultaneously in the voiceband channel.

A truly asynchronous, character-based and fast modem is thus defined.

Each character is encoded into a symbol of time duration less than or equal to 2,080 microseconds ($8 \times 200 + 480 = 2,080$), so that at least 480 characters can be transmitted per second, a rate superior to a standard 4,800 bps modem.

Choosing four frequencies at or above 2,500Hz and encoding two bits (dibits) into one halfwave defines an AHEAD modem, which can transmit in excess of 960 characters per second using the same design. This rate compares to a transparent 9,600 bps modem.

But why go through all this trouble to arrive at 4,800 bps and 9,600 bps modems, which have been around for decades? Here are at least 10 reasons:

(1) AHEAD modems are the first truly asynchronous modems at speeds higher than 1,200 bps. Single characters are transmitted in a little more than one or two milliseconds. There is no overhead.

(2) The modems are frequency-based. *Frequencies* stabilize faster and are distorted less than amplitude and phase. Using only frequencies to carry information gives AHEAD modems the edge over all higher-speed modems when used with less-than-ideal voiceband channels and, in particular, mobile radio channels.

Because amplitudes and phases are not relevant, existing radio transceivers can be used. *A speaker output and a microphone input are all that is needed.* No other modem technology can work this way.

Even the automatic gain controls (AGCs) used in many radios pose no problem. Traditional radio data links with speeds higher than 2,400 bps require access to the voltage-controlled oscillator (VCO) or other internal radio components. AHEAD can achieve 9,600 bps and more without any connection to a transceiver's internal components.

(3) AHEAD is fully developed for physical speeds as high as 10,000 bps and still has potential for improvements in features.

For example, the start signaling can be varied to provide an addressing scheme with no overhead.

Also, selecting 16 frequencies at or above 2,500Hz and encoding four

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RHS-3 Single Earpad



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Circle (37) on Fast Fact Card

DECIBEL

Trouble-free dependability? An airport has used Decibel antennas for 20 years. With no problem!

Six DB408 UHF Antennas were installed 20 years ago at one of the world's largest airports and "they have been working fine ever since!" The antennas, with Decibel filter products, provide six Tx/Rx channels: three for public safety and fire, two for ground transportation and one for maintenance.

Another Example

During the bad San Francisco earthquake in 1989, a DB222 aluminum antenna near the center of the quake continued to operate throughout the upheaval while another manufacturer's antennas were destroyed. Furthermore, not one of the 13 DB222s and DB224s located on California mountain tops has failed in 10 years' of service.

Leadership Since 1947

You can depend on Decibel for the most reliable aluminum antennas. As the leading manufacturer of land mobile base station antennas since 1947, we offer the largest selection and the finest quality.

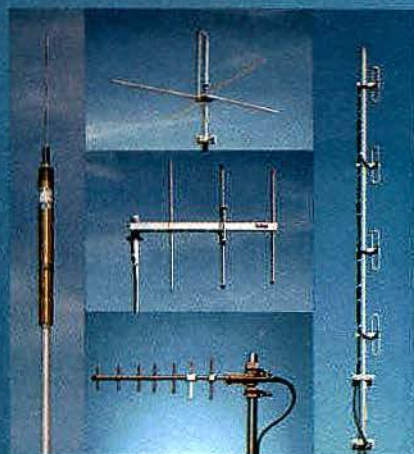
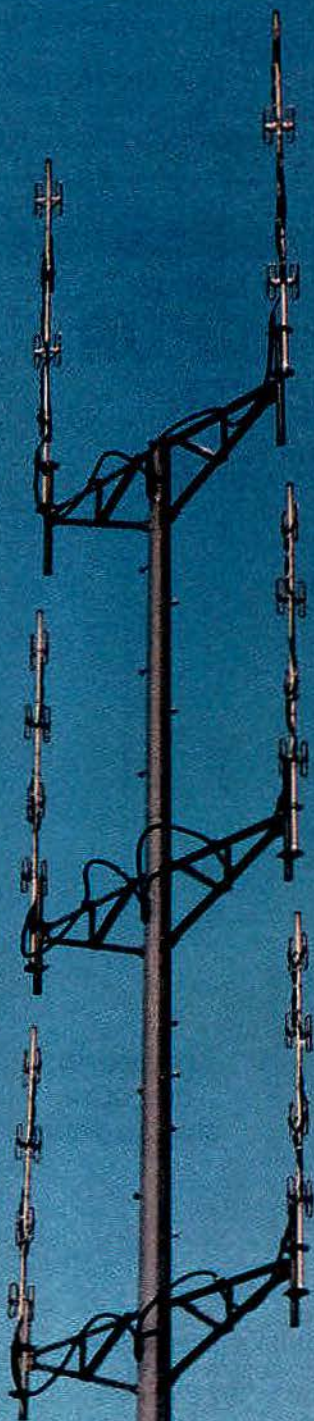
We build them strong with 6060-T6 aluminum alloy, with clamps of galvanized steel and V-bolts of stainless steel. For moisture resistance we utilize HELIAX® and VAPOR-BLOC® cables and molded harnesses with joints that are electrically, chemically and mechanically joined.

They're lightweight, virtually immune to static and lightning, and resist winds to 100 mph (161 km/hr) or more!

Use the toll-free HOTLINE to FAX us your requirements:

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VAPOR-BLOC is a registered trademark of Decibel Products.



L to R: DB205 coaxial for 33-174 MHz, DB201 ground plane for VHF/UHF, DB230 VHF Yagi with 7 dB gain, DB499 806-906 MHz Yagi with 10 dB gain, and DB411 UHF offset with 9 dB gain.



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*Warehouses that are qualified and certified to stock and tune certain filter products.

Factory Authorized Warehouses: Antenna Farm, Overland Park KS; Cartwright Communications*, Cincinnati OH; Communications Associates, Joliet IL; Communications Express, Clifton NJ; Communications Works*, Denver CO; Hutton Communications*, Dallas TX; Norcross GA; Marketronics*, Sunrise FL; Primus Electronics, Joliet IL; Talley Electronics*, Hayward CA; Santa Fe Springs CA; San Diego CA; Phoenix AZ; Tescos*, Hunt Valley MD; Sparks NV. In Canada, Allen Telecom Canada, Pickering, Ontario.

Circle (38) on Fast Fact Card

bits into one halfwave yields an AHEAD modem with throughput speeds higher than 19,200 bps. And this is an *asynchronous* modem.

Third, AHEAD modems have built-in encryption. The defining frequencies and channel parameters must be known to detect and decode data.

(4) AHEAD is highly spectrum-efficient.

The absence of a signaling rate and the continuous phase symbols reduce the requirements to passage of a band, which includes the defining frequencies. Voice and data or data and video signals thus may coexist without problems.

(5) The modems are basically digital. (See Figure 3 on page 36.) Simple microcontrollers can be used

to implement the technology, guaranteeing low manufacturing costs and allowing miniaturization. In addition, operating environments are fairly unlimited.

(6) The modems are self-learning. New voice communication equipment is easily interfaced. Manufacturers can implement a function that learns the basic characteristics of the entire channel without user interference.

Once established, those characteristics (called *profiles* in the context of AHEAD) can be used over a wide range of setups. No tuning, trimming or understanding is required. In contrast to existing modems, this procedure is necessary only once. Optional real-time adaptations can only improve the performance.

(7) AHEAD is software-based. Changing frequencies or parameters or features is reduced to the exchange of programs. Imagine what this means in terms of serviceability and updates.

(8) AHEAD is universal. This patented technology can be used with all voice transmitting equipment. The same modem is suitable for radios and telephones.

Prototypes have been tested over telephone systems in Europe and North America. The same prototypes were used in conjunction with HF, VHF and UHF radio equipment with excellent results.

Because the future has in store various combinations of telephone and radio technology for voice communication, AHEAD arrived at just about the right time.

(9) AHEAD is efficient. Tests have shown that the modem's error rates are far superior to those of all other modem technologies. They exceed those of FSK, which is the most robust modem technology in use today.

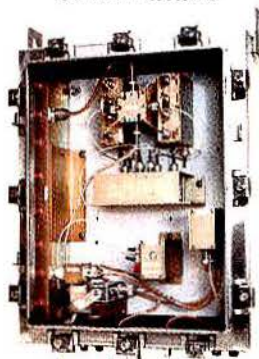
(10) The modem uses existing communications equipment for data links.

No special or modified radios are needed. Even acoustic coupling to a radio channel or telephone line yields excellent results—and all this at a speed higher than most modems in use today.

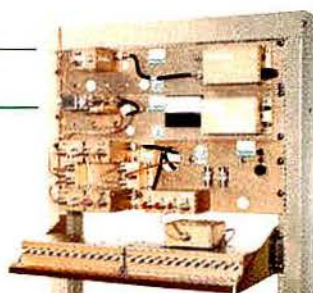
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Circle (39) on Fast Fact Card

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- Works with an AC adapter (115v AC or 220v AC) as well as with a cigarette lighter adapter cord in a car, boat, or plane.

MasterCharger II®

- Can charge any Nicad Battery from 6v to 13.2v
- Will charge a battery in 5 to 8 hours, then automatically goes into a reduced current state.
- 115v or 220v AC adapter included.
- Utilizes a taper charge principle.

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Circle (40) on Fast Fact Card

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Product/services showcase

The following pages contain mobile radio products and services of advertisers in this issue. Information is provided by the advertisers. For more information on these products, circle the corresponding Fast Fact number found on the card on page 95. Also, refer to the Advertisers' Index on page 92 for the page reference to the company's advertisement.



Land Mobile Radio Communication Products

The **Telex** radio communications product line includes communication headsets: Ear Mike in-the-ear microphone and receivers designed for portable two-way radios; MagnaCom modular intercoms for emergency and utility vehicles; and MagnaRope, an intercom system with its cable imbedded into a rescue rope.

Circle (351) on Fast Fact Card



Communications Control Console

The Ultra-Com PRO features "Screen-maker" and "Customizer" programs that enable the operator to design screens to fit specific operating applications. The unit is available with standard color monitors, as well as 20-inch and 14-inch touch-screen color monitors.

Modular Communication Systems

13309 Saticoy St.

North Hollywood, CA 91605

818-764-1333

Circle (352) on Fast Fact Card



Bandpass Filter For Mobile Radio Transmitters

Model 9270 preselector preserves the receive band of conventional mobile phone and deletes nearby RF noise. Passband frequency is 806MHz to 821MHz. Insertion loss is 0.75dB maximum and 0.40dB typical. Attenuation is 60dB minimum at center frequency ± 45 MHz. VSWR is 1.50:1.

Microwave Filter

Circle (353) on Fast Fact Card

Network Your SMR System Now

Zetron's FASTNet digital switch provides wide-area network services for trunked radio systems. FASTNet offers field-tested features that make it the most advanced network controller available today. • All-site dispatch • DID trunk splitter • Voice messaging • Site-to-site roaming • Least cost routing • Call forwarding • ESAS compatibility

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Circle (354) on Fast Fact Card



Telepower Conditioner/Analyzer

Telepower conditioner/analyser advanced battery maintenance systems from **JBro** provide maximum reliability at cost-effective prices. Five models condition, analyze and charge as many as six batteries simultaneously. They are ideal for NiCd rechargeable batteries for land mobile radios, cellular telephones, medical devices and laptop computers.

Circle (355) on Fast Fact Card



Caller ID ANI Decoder

The caller ID ANI system identifies each radio caller. The system from **Control Signal** provides leading and trailing IDs using FSK signaling and is compatible with all radios. The ID-700 decoder (above) has a 32-character LCD. Features include reverse scrolling, a printer port and an RS232 port.

Circle (356) on Fast Fact Card



Micro Series Pagers

Uniden Micro series pagers are available in any quantity. Many VHF, UHF and 900MHz frequencies are stocked for immediate shipment. Call for more information.

VCP International

800-527-9366

Circle (357) on Fast Fact Card

900MHz Low Profile Data Collection Antenna



The S9062P was specially designed and optimized for spread spectrum data collection applications. This antenna has a 6dBd hemispherical pattern for excellent fill in. Linear and circular polarization versions are available. Designed for wall or ceiling mounting, the S9062P measures 12" x 12" x 1/4". Customized versions are available in OEM quantities.

Cushcraft/Signals

48 Perimeter Rd.

Manchester, NH 03103

Circle (358) on Fast Fact Card



LANCERnet Low Cost Trunking

Trunk conventional radio equipment with affordable, feature-rich network systems. Complete control of multiple channel mobile telephone systems. Local Area Network Central Exchange Radio (LANCER) offers: Automatic channel allocation, intersystem privacy, conference and group calling, and much more. For information contact CES at 1-800-327-9956.

Circle (359) on Fast Fact Card



Powerpac+

Powerpac+ will allow you to power your hand-held radio and portable cellular phone for 6 to 10 times longer than a typical NiCd battery pack. The unit includes: • Heavy duty pouch and belt • 6V at 10A or 12V at 4A lead-acid battery • Charger • Adapter

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Circle (360) on Fast Fact Card



Pager Crystals

Bomar introduces reliable 900MHz crystals for Motorola Bravo Plus, Bravo Express and Dimension 2000 pagers. Every crystal is manufactured to precise specifications and comes aged for clean, drift-free reception. The crystals carry a lifetime guarantee. Call 800-526-3935 or fax 800-777-2197.

Circle (361) on Fast Fact Card



Remote Comparator Display

The Smartswitch II remote comparator display monitors and controls voting receiver systems with a PC or console. It can be used with lease-line or dial-up modems. Version 2.0 includes error logging and expanded modem support.

Combined Technologies

513-595-5900

Circle (362) on Fast Fact Card



Panel Antenna for the 220MHz Band

The BP7-220 offers a building block approach to planning coverage and gain for sector, quasi-omni and less than omni patterns. All BP7-220 panels exhibit a maximum VSWR of 1.2:1, operate from 216MHz-230MHz and have 7dBd of gain. Contact **Scala** about its full line of 220MHz antennas.

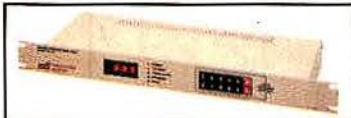
Circle (363) on Fast Fact Card



Base Station Testing for TDMA/AMPS

The HP 8921A/D cell-site test set from **Hewlett-Packard** offers customized automated procedures based on manufacturer's recommendations for faster maintenance of AMPS/NAMPS and TDMA cellular systems. The built-in computer controls the base station, freeing up the laptop computer.

Circle (364) on Fast Fact Card



Repeater Tone Panel

Model TP-38 is a full-function, micro-processor-controlled repeater tone panel providing complete interface between receiver and transmitter. CMOS circuitry allows reliable service with low power consumption. The unit from **Communications Specialists** has been tested for 10 years and is competitively priced at \$399. Custom applications are also available. For information call 800-854-0547 (West Coast).

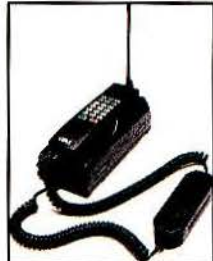
Circle (365) on Fast Fact Card



EMV 499 0A UHF Radio

The EMV UHF radio comes with a five-year parts and labor warranty. It is a 114-channel, UHF mobile that covers the 403MHz-470MHz range. The unit from **Bendix/King** features an eight-character, 14-segment vacuum-fluorescent alphanumeric display. It operates from 10W-40W and is the smallest mobile in its class. It requires no manual service adjustments and is completely tuned and programmed by software.

Circle (366) on Fast Fact Card



Secure- Net Voice Privacy Unit

Secure cellular, landline and MTSO systems locally or through a nationwide network. Simple plug-in voice privacy unit from **Transcrypt** enables automatic or push-button privacy. Secure-Net 800 number provides nationwide network access. Excellent voice quality. Low power consumption. Several models.

Circle (367) on Fast Fact Card

Product/services showcase

New SMR Antennas

A new series of mobile trunking antennas offer high performance for demanding 800MHz and 900MHz applications. Select from unity, 3dBd and 5dBd models in various mount and cosmetic styles. All offer copper-plated whips, dual-shield coax and silver-plated connectors in complete packages.

Larsen Antennas

800-426-1656

Fax 800-525-6749

Circle (368) on Fast Fact Card



TDMA Cellular System Analyzer

IFR Systems' FM/AM-1600CSA provides the capability to decode and display control messages being transmitted by an IS-54 dual-mode cellular system. The analysis function can be performed on a user-specified forward control channel, forward digital traffic channel or forward voice channel.

316-522-4981

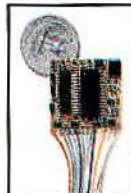
Circle (369) on Fast Fact Card



Radio-telephone/Selective Call

Midian provides two custom products for Maxon SP2000/SL70 portables. Features include a DTMF radiotelephone encoder/decoder/ANI/transponder with optional 10-code inversion scrambler, 16-channel trunking scan, multicity trunk listing; or a multitone, multi-format ANI/selective call encoder/decoder module with optional 10 code inversion scrambler.

Circle (370) on Fast Fact Card



CDEU-1 Subminiature ANI Encoder/Decoder

The unit from **Cimarron Technologies** is full-featured, two-way,

GE-STAR compatible for mobile and portable applications:

- Man-down alarm with acknowledgement
- Remote radio kill with ack
- Remote open mic command with ack
- Remote radio enable with ack
- Selective, group, all call
- Auto radio check
- Trunking compatible

Circle (371) on Fast Fact Card



32-Channel Portable Transceiver

Vertex Radio Communications, the Land Mobile Division of Yaesu

U.S.A., introduces a 32-channel portable transceiver, the VX-500. The

VHF version has an invertible 4-character alphanumeric display, priority scan or dual mode

watch, CTCSS and DCS included, high-capacity (1,200mAh) battery and Mil Std 810 C, D, E and intrinsically safe (I/S) specifications, as well as D.O.C. RSS 199 specifications. A UHF version will be available shortly.

Circle (372) on Fast Fact Card



Radiopaging Terminal

The Page Maker 8 is a sophisticated radiopaging terminal designed for smaller markets or special applications. The terminal from **Unipage** provides the advantages of on-site voice, tone, numeric or alphanumeric paging to hospitals, manufacturing plants and PCPs. It works with paging systems such as the Motorola Alert Central Wireless Monitoring System.

Circle (373) on Fast Fact Card



California Antenna Site Tower Space

Meridian Communications has space available at its 38 facilities. The company's newest

site is Flint Peak, shown here. It is located near the Rose Bowl, and it covers Pasadena, Glendale, Burbank and the San Gabriel Valley. It is secure, air conditioned and has standby power. Call 818-888-7000.

Circle (374) on Fast Fact Card



X-Tra Talk Battery Eliminator

Centurion's new X-Tra Talk battery eliminator allows the adapter to be plugged into a vehicle's cigarette lighter to get maximum radio output, extended battery life and reverse polarity and current surge protection. Fits any popular two-way radio. Call 800-228-4563.

Circle (375) on Fast Fact Card



Solar Power Supply

Hutton's solar power supply "mini" series is available in sizes of 1W-hour/day to 230W-hours/day depending on the type of battery and solar module. 230W hours represents continuous operation of a 25W repeater talking for two hours per day. For more information, call 800-442-3811.

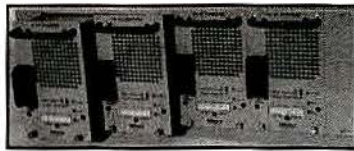
Circle (376) on Fast Fact Card



When Every Second Counts . . .

The Video Enhanced Communications Access and Control System from **Orbacom** uses state-of-the-art graphics that make the conversion from modular consoles to computer-operated dispatch positions easy. The "set up" screens on the CRT resemble the modules you are used to. Changes and expansion are made simple with as many as 10 screens in memory for different applications or personalized screens for each dispatcher.

Circle (377) on Fast Fact Card



Modular 24V-48V dc-dc Converters

Designed for cell-site power installations requiring more 48Vdc power in less space, the series 1625 converter shelf from **Wilmore Electronics** occupies only 7" of vertical rack space and can be equipped with four 20A plug-in converter modules. Modules feature LED bargraph ammeters, output-voltage test points, LED status indicators and form C alarm contacts.

Circle (378) on Fast Fact Card



2965 Radio Test Set

Model 2965 radio test set from **Marconi Instruments** includes a spectrum analyzer and tracking generator, a high-speed frequency counter that makes 1Hz resolution measurements in a matter of milliseconds, an extremely accurate power meter, a highly accurate signal generator and a Fast Fourier Transform (FFT) audio analyzer.

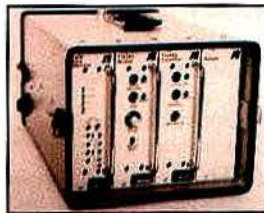
Circle (379) on Fast Fact Card



New Pro-5000 VHF/UHF Antennas

The Pro-5000 series, a new line of VHF and UHF mobile antennas offered by **Antenna Specialists**, boasts 22 models for all mounting requirements and frequency splits. Maximum moisture integrity is ensured by a new heavy-duty coil design (100% factory-tuned) using three separate O-rings.

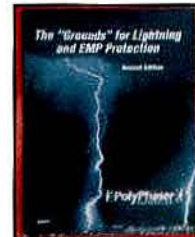
Circle (380) on Fast Fact Card



Repeater-In-A-Box

A portable cabinet the size of two briefcases, one on top of the other, can hold a complete 25W repeater. The repeater-in-a-box from **Tait Electronics** uses the same high-performance radio modules as the rack-mounted repeater configuration. Call 800-222-1255 for more information.

Circle (381) on Fast Fact Card



Hot Off The Press

The second edition of *The "Grounds" for Lightning and*

EMP Protection is now available. This 100-page publication is a comprehensive hands-on guide to proper grounding installation, measurement and maintenance for direct lightning strike survival.

PolyPhaser

P.O. Box 9000
Minden, NV 89423
800-325-7170

Circle (382) on Fast Fact Card



Checkmate IV

The Checkmate IV gives you the choice of a programmable decoder for field programming of tones to speed delivery and increase your options, or a reed-type decoder to give you the maximum sensitivity in areas where signal strength is weak. Call **Shinwa Communications of America** for information.

800-627-4722

Circle (383) on Fast Fact Card



Remote Control System

Model TSR200 is a telephone-style remote control designed for use with Motorola's Maxtrac 840, B7 radio. The remote from **CPI Communications** provides display of system and subfleet information, on-hook PTT capability, intercom capability between parallel remotes and the radio, speaker with volume control, scan button, scan LED, select button, system button, subfleet button and call LED.

Circle (384) on Fast Fact Card



Model CD-1 Communications Decoder

The CD-1 decodes and displays all 50 CTCSS and 104 DCS codes as well as all 16 DTMF digits in a compact 4.5- x 4.5- x 1.8-inch case. Powered from 12Vdc, the CD-1 from **Connect Systems** mounts on your service monitor, scanner or in a mobile. The CD-1 doubles as a remote programmer for the TP-154 repeater tone panel.

Circle (385) on Fast Fact Card

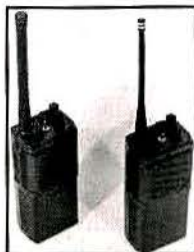
Product/services showcase



R-2600 Communications System Analyzer

The feature-packed R-2600 from **Motorola** is ideal for all testing needs, from conventional, two-way radios to cellular, paging, or other personal communication devices. Its extensive diagnostics make it ideal for laboratory and factory applications, as well as service shop and field use.

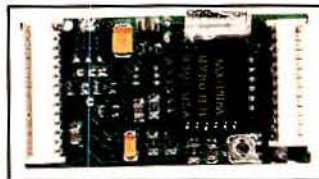
Circle (386) on Fast Fact Card



5W Crystal-controlled Radios

Dynamic VHF and UHF high quality, heavy duty, 5W crystal-controlled radios from **Monark International** are offered as an alternative to dealers that are fed up with bargain basement radios. The advanced SMD technology PCB offers the long-term reliability that today's dealers demand.

Circle (387) on Fast Fact Card



CADi Radio Fleet Call Manager

Model MX P25 encodes and decodes two-way radio SelCall tone signals to make a fleet safer and more efficient. This miniature adapter features ANI, status reporting, Man-Down/Emergency alarms and OTAR. Channel management is easier, and the dispatcher has better control over the system. Call **MX-Com** at 800-638-5577.

Circle (388) on Fast Fact Card



C-5200 Ten-line Console

Vega's C-5200 10-line, 4-frequency tone-control console for 19-inch rack or furniture mounting or desktop operation includes instant PTT switches and separate "unselected" volume controls. The optional SP-2 panel has two "selected" and "unselected" speakers. Options include dc/local/E&M control, 12 function tones, audio display, cross-mute, microphones, headsets, DTMF pad and decoders. Call 800-877-1771.

Circle (389) on Fast Fact Card

Cellular Look-alike Dual Band Antennas

The new disguised cellular look-alike antennas from **Sti-Co** are both dual band and broadband. The EF-150/450 covers 24MHz bandwidth in VHF and 20MHz bandwidth in UHF. The EF-450/800 covers 15MHz in UHF and 60MHz bandwidth in cellular. The elevated feed style cellular replicas are available in roof and trunk lip mounts. Call 716-662-2680.



Circle (390) on Fast Fact Card

New! 1993-94 Catalog & Technical Reference Guide

This FREE 400-page catalog and pricer is full of charts, graphs, photographs, cross reference and technical information. All the well-known brands are included... Andrew, Antenna Specialists, Bird, Celwave, Decibel and many more.

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Circle (391) on Fast Fact Card



AutoCELL Autotune Tx Combiner

Model ATG7020 4-channel 820MHz-960MHz cellular Tx combiner can be phased with additional 4-channel AutoCELLs for as many as 24 channels. Designed with ceramic resonators from Antenna Specialists and patented technology from **Decibel's** Sentry 8000, AutoCELL makes frequency reallocation a reality.

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Broadband, Directional RF Wattmeter

Model 4304A from **Bird Electronics** is a Thruline RF wattmeter with five RF power ranges from 5W to 500W full scale. This portable unit measures both forward and reflected RF power levels in 50Ω two-way communications. Model 4304A offers stable performance to 1,000MHz.

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25th Anniversary Tone Catalog

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Color Touchscreen Consoles

Avtec's Access system controls radio and telephone lines in one integrated system. Airlines, military and public safety agencies can take advantage of this high-capacity system. Features include paging, auto-dial and full conferencing with one touch.

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4015 Radio Tester

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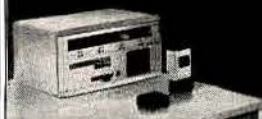
Full Line Catalog

The catalog features a full line of land mobile, cellular and base station antennas and accessories. Catalogs are available nationally through authorized **Maxrad** distributors and factory representatives.

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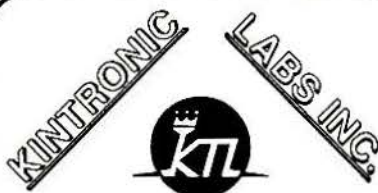
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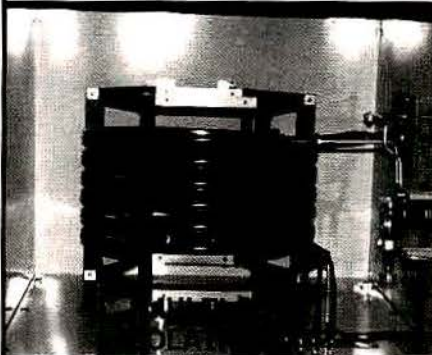
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Technically speaking

(continued from page 8)

The formula for finding the proper derating factor is:

$$F_d/(F_d + R_d)$$

where

F_d = forward power dissipation (watts)

R_d = reflected power dissipation (watts)

Because finding F_d and R_d is a bit tedious in itself, the following formula offers a quicker way to find the solution.

For single-section isolators:

$$D_f = \frac{1}{1 + \text{antilog} \left[\frac{(L+R)}{10} \right]}$$

where

D_f = derating factor

L = insertion loss

R = return loss

Be certain to enter L and R as negative values because they represent a loss.

$$D_f = \frac{1 + \text{antilog} \left[\frac{L}{20} \right]}{1 + \text{antilog} \left[\frac{L}{20} \right] + \text{antilog} \left[\frac{L+R}{10} \right]}$$

For dual-section isolators:

Again, be sure to enter L and R as negative values.

Figure 2 on page 8 can be used to find the derating factor for single-section isolators with 0.5dB insertion loss and for dual-section isolators with 1.0dB insertion loss.

For example, a certain single-section isolator has an input power rating of 150W under well-matched operating conditions (high return loss, low VSWR). Suppose that the return loss drops to 3dB. According to curve A on the graph in Figure 2, the derating fac-

tor for a return loss of 3dB is 0.69.

Thus, the normal input power rating should be reduced by a factor of 0.69. The reduced input power level should be no more than 69% of the specified maximum or $0.69 \times 150W = 103.5W$. This reduction compensates for the increased heating effect of the reflected power. For dual-section isolators, use curve B on the graph.

Dummy load size

Technically speaking, the dummy load connected to port 3 must be able to dissipate the full transmitter power if a worst-case mismatch occurs at the output (port 2). If such a worst-case mismatch occurs, almost all of the transmitter power will be "dumped" into the dummy load. If the load is incapable of dissipating this much power, the dummy load and possibly the isolator will be damaged from overheating.

Such worst-case mismatches indeed can occur, but usually what the designer wants to protect against is an-

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Technically speaking

tenna damage that causes the VSWR to soar and return loss to drop.

For example, if the isolator output is connected to an antenna through a feedline with a 1.5dB loss and a worst-case mismatch occurs at the antenna, the return loss at the feedline input will be 3.0dB. Thus, half of the output power will be dumped into the dummy load and dissipated as heat.

Usually, the size of the load is chosen to be approximately 50% of the transmitter output power; nonetheless, there are no hard and fast rules. Obviously, you would not elect to use a 200W dummy load if the transmitter were rated at 50W! Be conservative, but do not take it to the extreme. Use the common-sense approach.

The graphs in Figure 3 on page 8

can be used to determine the load requirements for a given amount of return loss. Curves are given for both single- and dual-section isolators.

As an example, suppose the return loss is 5dB. For a single-section isolator, the load requirement would be approximately 25% of the transmitter power. The following formula can be used to calculate the load requirement for a single-section isolator:

$$L_f = \text{antilog} \left[\frac{R+2L}{10} \right]$$

where

L_f = load factor

R = return loss in dB

L = insertion loss in dB

For dual-section isolators, the formula is:

$$L_f = \text{antilog} \left[\frac{R+1.5L}{10} \right]$$

Be sure to enter R and L as negative values.

Harmonics

In *Technical Papers* published by EMR, Phoenix, Bill Lieske writes:

"When RF power is conducted by the ferrite junction, harmonic responses are likely in most designs, and it is found that, possibly due to impurities or non-linearities in the ferrite mix and other phenomena, harmonic energy produced by a transmitter may be conducted through an isolator and, in some cases, weak harmonics can be generated in the ferrite material itself."

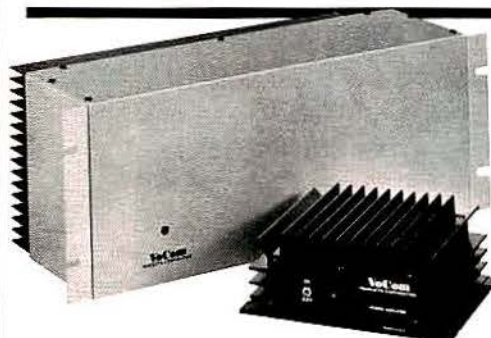
For that reason, it is important to use a harmonic filter between the isolator output and the antenna. (See Figure 4 on page 54.)

Moreover, if a *pass* cavity is connected between the isolator output and the antenna (as shown in Figure 5 on page 54), the harmonic filter is unnecessary. Figure 5 represents a typical repeater setup.

Isolator testing

After installing an isolator, you should confirm that it provides the iso-

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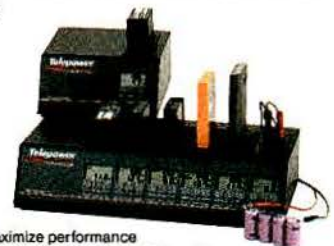
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Technically speaking

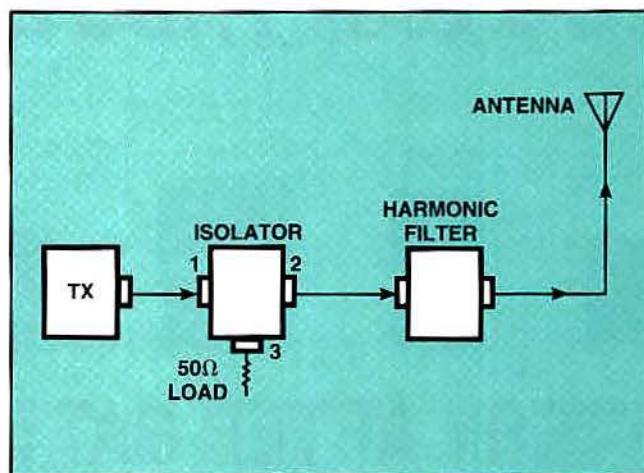


Figure 4. To suppress any harmonics caused by the isolator, a harmonic filter is used between the isolator output port and the antenna.

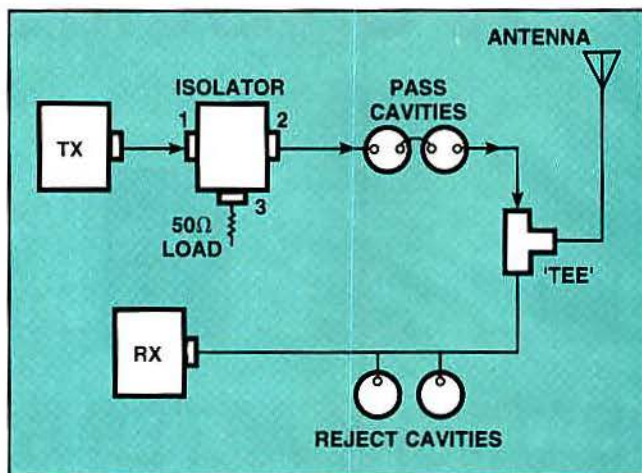


Figure 5. When a bandpass cavity follows the isolator, no special harmonic filter is needed. This configuration is typical of a repeater setup.

lation that the manufacturer specifies.

A simple way to measure isolation is shown in Figure 6 to the right. Set the signal generator to 0dBm, and measure the signal level (at the input port) on the spectrum analyzer.

First, feed the signal generator output directly into the spectrum analyzer to establish the 0dBm reference on the spectrum analyzer display. If the manufacturer specifies the isolation figure

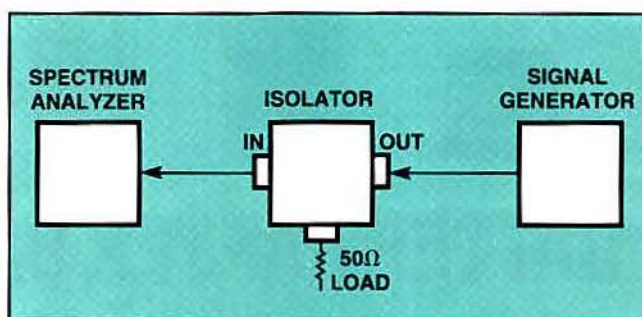


Figure 6. This setup is used to check the isolator's isolation figure. Notice that the signal is fed into the isolator output port while the measurement on the spectrum analyzer is taken at the input port. The difference between the signal generator level and the level measured on the spectrum analyzer is equal to the isolator's isolation figure.

to be 35dB, then the signal level measured on the spectrum analyzer should be at or below -35dBm. If you measure an isolation figure radically different from the specified figure, something is wrong, either in the isolator or in your test equipment.

The insertion loss should be checked, too.

Figure 7 on page 56 shows a simple way to measure the insertion loss. At (a), the forward power entering the input port is measured and re-

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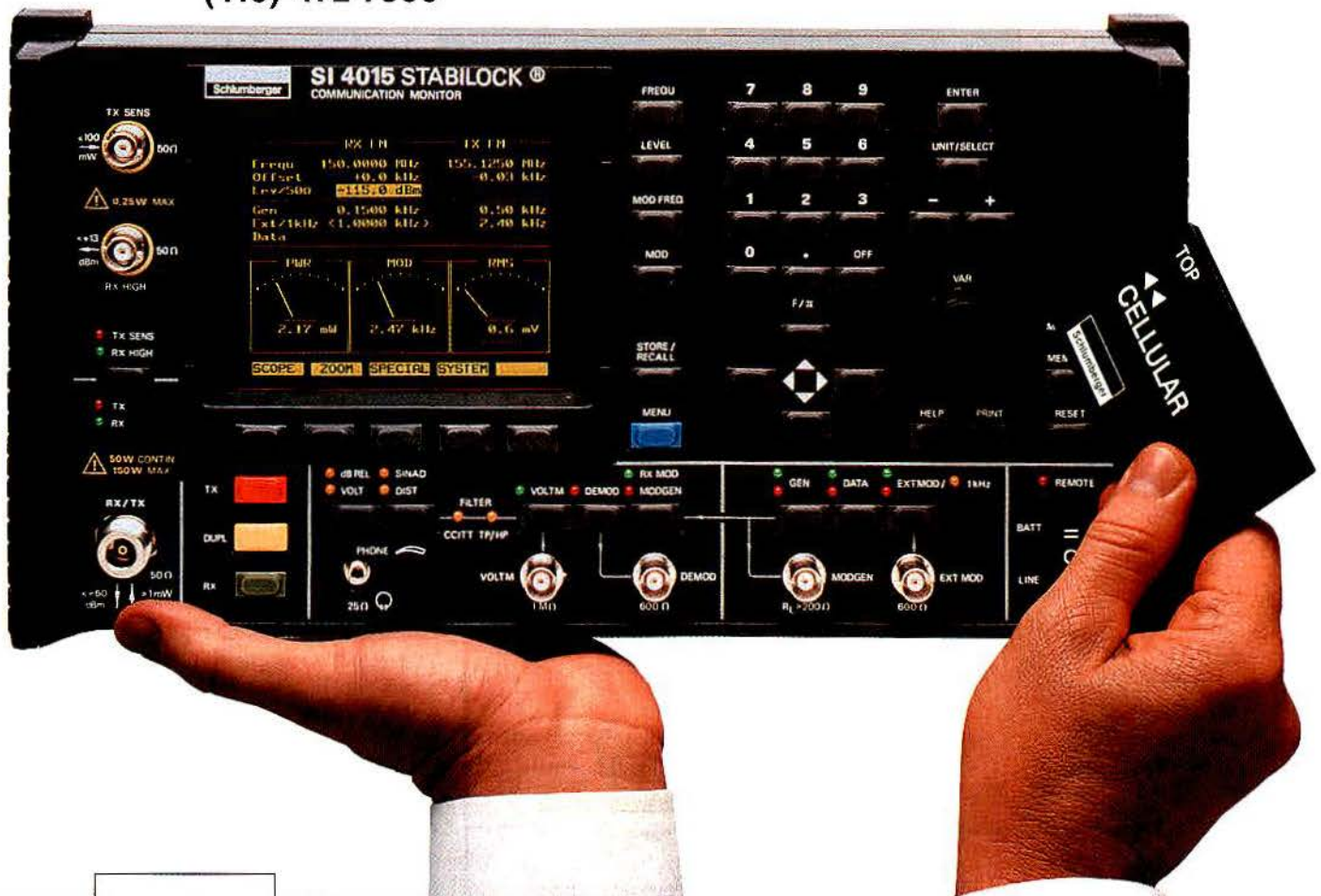
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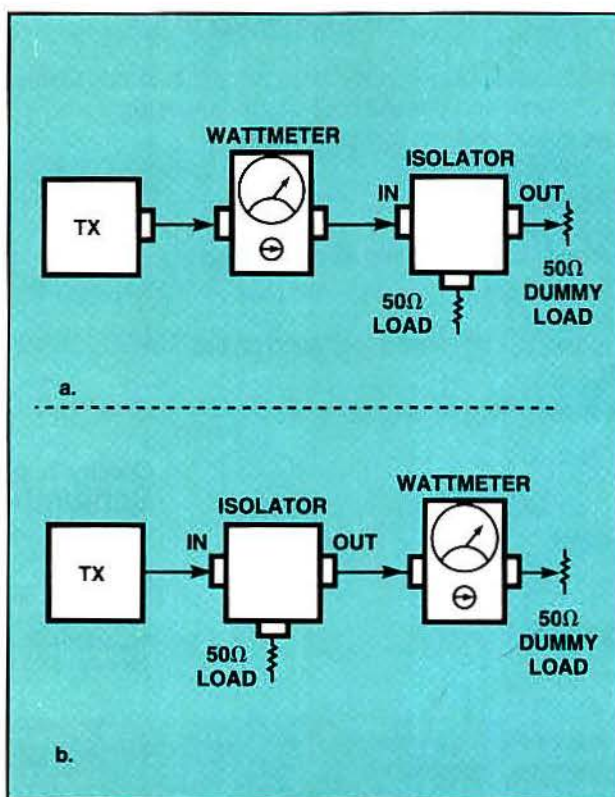
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Technically speaking

Figure 7. This setup can be used to measure the isolator's insertion loss. At (a) the wattmeter measures the input power to the isolator. At (b) the wattmeter measures the isolator output power. The insertion loss then is determined by the formula $10 \log(P_i/P_o)$.



recorded as P_i . At (b), the forward power exiting the output port is measured and recorded as P_o . The insertion loss then is found by using the formula:

$$\text{Insertion loss} = 10 \log(P_i/P_o)$$

For example, if the input power P_i is 100W and the output power P_o is 90W, the insertion loss is $10 \log(100/90) = 10 \log(1.111) = 0.46\text{dB}$. Any radical departure from the specified figure should be investigated more closely.

Simplex base station hookup

When hooking up an isolator to a simplex base station, be certain to insert the isolator in the line between the transmitter output and the antenna relay.

If the isolator is inserted beyond the antenna relay (between the antenna relay and the antenna), the antenna will be effectively isolated from the receiver input, rendering the receiver virtually inoperative. (See Figure 8 on page 58.)

Proposed standard

Lieske offers the following information as a recommended standard to be used by transmitter site managers in controlling intermodulation interference among users:

"An RF isolator shall be provided immediately following each transmitter and shall provide a minimum of 30dB of isolation. In addition, the isolator shall be followed by a cavity resonator, harmonic, bandpass or lowpass filter to ensure that all conducted or generated harmonics are at least 100dB below the transmitter carrier power measured at the antenna system feedpoint.

"In the event that an intermodulation product resulting in interference to any on-site receiver is traced to a given transmitter, additional isolators or isolator sections shall be provided as required to suppress intermodulation products to a non-interfering level.

"All isolators shall maintain the minimum of isolations herein defined throughout the ambient temperature ranges to be found at the site and up to the maximum duty cycle of the radio transmitter concerned.

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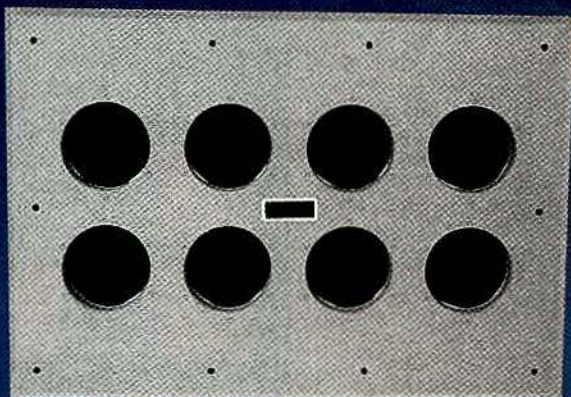
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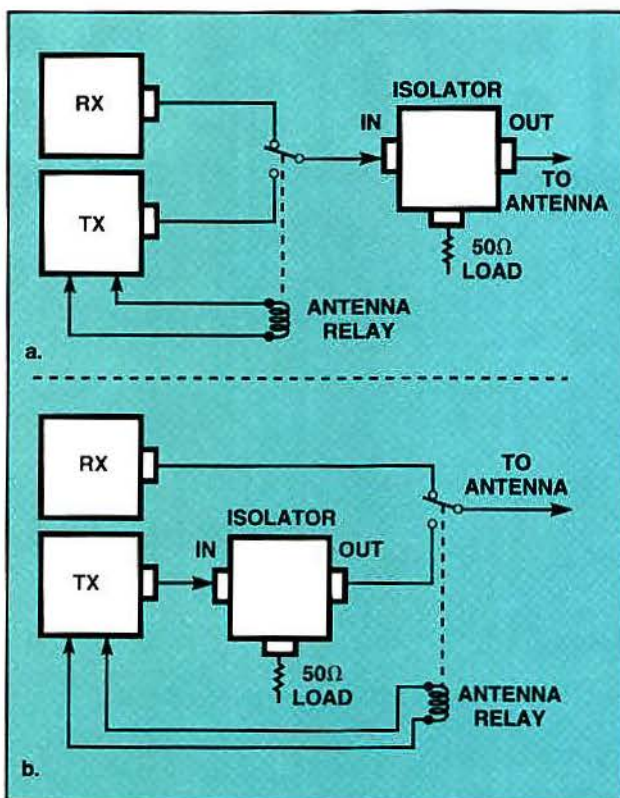
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Technically speaking

Figure 8. At (a), the isolator is incorrectly inserted in the common antenna line to the transmitter and receiver. If this setup were used, little signal could reach the receiver input because the antenna is, in effect, isolated from the receiver. At (b), the isolator is installed between the transmitter output and the antenna relay. In this arrangement, the isolator is not between the antenna and the receiver input; thus, the received signal is not isolated from the receiver input.



interference still be found after the application of up to three cascaded isolators or three isolator sections, further reduction of intermodulation products shall be accomplished through (a) the addition of cavity filters, (b) through separation of antennas to reduce couplings, (c) a combination of (a) and (b), or (d) the adjustment of transmitter power output powers as needed to reduce the interference to an acceptable level."

It is hoped that this column, along with last month's, has answered some of your questions about isolators.

For the "purists," a computer program that computes the derating factor and the load requirement of typical isolators (single and dual) is available from the author at P.O. Box 15178, Spartanburg, SC 29302. The cost is \$5, including shipping and handling. The program is available only on a 5.25-inch floppy diskette in IBM format.

Additional information about isolators is available from various manufacturers.

Two manufacturers that can furnish additional tutorial information about isolators are: EMR, 22402 N. 19th Ave., Phoenix, AZ 85027; and Tx Rx Systems, 8625 Industrial Parkway, Angola, NY 14006.

References

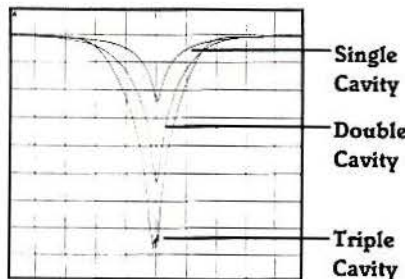
1. Alcivar, Ernesto A., "An Elementary Introduction To Ferrite Isolators, Circulators and RF Loads," Tx Rx Systems, Angola, NY, 1992.
2. "Ferrite Isolator Power Derating & Isolator Load Power Requirements," Tech-Aid Bulletin #92001, Tx Rx Systems, Angola, NY.
3. Lieske, William F., *Technical Papers*, EMR, Phoenix, 1991.

TUNABLE NOTCH FILTER

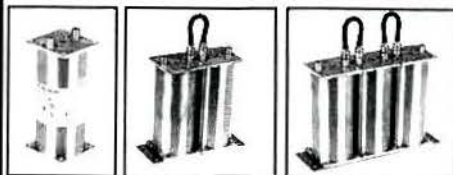
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Hutton gives awards to top vendors

Hutton Communications, Dallas, a radio communications and cellular telephone equipment distributor, has given awards to several vendors for their commitment to customers and stable distribution practices.

The top five awards went to Andrew, Orland Park, IL; Siemens Solar Industries, Camarillo, CA; Sat-Pak, Redmond, OR; IFR Systems, Wichita, KS; and The Antenna Company, Broadview, IL.

Other factors scored in evaluating vendors include delivery practices, service methods and contribution to end-user satisfaction. Sales, finance and advertising units within Hutton were considered, too.



Pat Speed, Hutton's sales manager, presents a plaque to Rich Doolittle, Andrew's distribution accounts manager.

Motorola division changes name to reflect new focus

Motorola's Government Electronics Group has changed its name to the Government and Systems Technology Group (GSTG) to reflect its new business focus on current government customers, renewed focus on international markets, commercial business and Iridium, the global personal communications system. The division's headquarters remains at 8201 E. McDowell Road, Scottsdale, AZ 85252.

Lindgren becomes a Veratec distributor

Lindgren, Glendale Heights, IL, has become the exclusive marketer and distributor of Veratec's Saf'N'Shielded fabric and tape for North, Central and South America. Veratec, a division of International Paper, designs and manufactures non-woven fabric for diverse applications. Saf'N'Shielded fabric is a metallized wall covering designed to prevent electromagnetic interference (EMI). The fabric is available in three levels of shielding effectiveness (40dB, 60dB and 80dB) in 10KHz-18GHz frequency ranges.

Racotek supplies mobile data systems to courier industry

Racotek, a Minneapolis-based wireless mobile data and voice communications services company, has entered into a partnership with Datatrac, an Atlanta-based computer supplier for couriers. Under the agreement, Datatrac will integrate the RacoNet system with its Courier Order Processing System software to provide both data and voice communications for its courier customers.

Ericsson supplies paging transmitters to PageNet

Ericsson Messaging Systems, Woodbury, NY, has been awarded a \$4 million contract from Paging Network (PageNet) to supply Compact 925 digital paging transmitters. The Compact 925 is a 900MHz, 250W digital paging transmitter that measures 10.4" high by 19" wide and weighs 56 pounds. PageNet is the largest paging carrier in the United States, providing paging service in 67 markets in 22 states. The transmitters were purchased for expansion of PageNet's operations in 1993.



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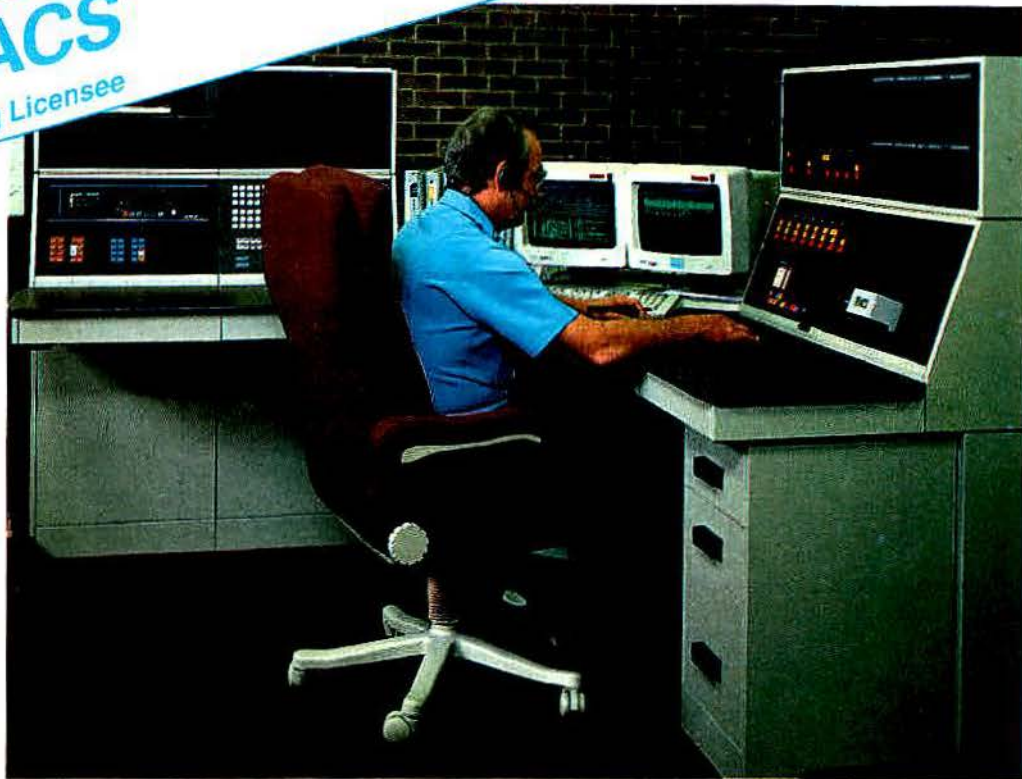
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Circle (56) on Fast Fact Card

FCC advances regulatory agenda despite commission vacancies

By Robert H. Schwaninger Jr.

If you were wondering whether the FCC can function with three commissioners instead of the normal complement of five, fear not.

The federal agency is showing that a lot can happen, even during the transition period. In fact, more than a few heads are spinning in Washington, trying to keep up with all of the pending rulemaking proceedings and Congressional activity that threaten to alter the way the FCC and operators do business.

Congressman Edward Markey (D-Mass.), chairman of the House Subcommittee on Telecommunications and Finance, has informed industry sources that legislation is being marked up that would consolidate all for-profit communications services under Title II of the Communications Act. This means that specialized mobile radio (SMR) and other private carrier services would find themselves in the same basket with common carrier services.

Although the bill's particulars have not

been published and the legislation still is in the early stages, it appears as though SMR and private carrier systems are being exempted from tariff requirements and are being insulated from state regulation. Open questions are the treatment of dispatch services and whether the proposed reclassification of what traditionally have been private services will enable SMR and private carrier system operators to receive interconnection agreements on a par with preferential treatment now given to common carriers.

Spectrum refarming

Meanwhile, spectrum refarming continues to be debated before the FCC as the commissioners use round table discussions to separate the possible from the impossible.

Participating manufacturers appear to agree that 12.5kHz radio channel spacing is possible, but the jury is out on any lesser spacing, and the resistance to narrower spacing might be too great to allow the FCC to adopt a timetable for future conversion.

If, in fact, the FCC and industry representatives have agreed that 12.5kHz channel spacing is possible, the next question is how to adopt the new standards. Expect more consensus-building on that topic before the FCC decides to move forward formally.

At present, the FCC is focusing its attention on manufacturers' comments and on suggestions offered by public safety agencies. Some manufacturers are asking the FCC to take a wait-and-see approach, rather than to legislate a 5kHz channel spacing standard now. The more cautious manufacturers are reminding the Commission that wideband technologies may prove to be more spectrum-efficient and that the FCC should not paint itself into a corner by acting too soon.

Conspicuously absent from the most recent discussions have been the dealers, community repeater operators, private carrier system operators and the small-to-medium-size operators that probably will bear the brunt of whatever decisions ultimately are made. When a particular manufacturer tells the FCC that rules must be adopted immediately to codify 5kHz spacing, one keeps waiting to hear from the other side of the table. Right now, those chairs are empty.

One nagging idea keeps coming back to me, and on first blush it appears too far-fetched—but who knows?

If the FCC reduces the number of frequency coordinators to three (as it has proposed), and then Congress lumps all for-profit entities together under one umbrella, will the National Association of Business and Educational Radio (NABER) eventually become the recognized frequency coordinator for radio common carriers? It's time to reshuffle my Tarot cards.

Spectrum auctions

Back on Congressional Hill, the debate regarding spectrum auctions continues.

The president of the Cellular Telecommunications Industry Association (CTIA), Tom Wheeler, testified that spectrum auctions should begin with allocations for Personal Communications Service operations. Looking beyond that "test market," other industry representatives once again pleaded for opportunities for small-to-medium-size businesses, including the use of the FCC's Pioneer's Preference designation, to ensure that an auction winner

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Schwaninger, *MRT's* regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC.

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uses the spectrum as planned and paid for.

However you look at it, it appears as though auctions are coming. It is just a question of where, when, how much and for which spectrum.

Regarding use of the Pioneer's Preference standard to determine eligibility to participate in an auction, a little logic and law might demonstrate that this suggestion is unworkable.

The grant of a Pioneer's Preference designation presumes that the recipient truly has brought forth a new technical concept for the spectrum use. As numerous FCC proceedings demonstrate, the question of when is new really new is subject to enormous interpretation.

The FCC really does not want to debate that point, and some of the commissioners have admitted privately the "black hole" of time-consuming deliberations involved in deciding when to award a pioneer preference. Considering the enormous resources that the auction participants may be expected to possess, one easily can see that an application for a Pioneer's Preference designation even from one of them might bring enough litigation from the others to keep a room full of engineers and

lawyers working far into the next century.

Vehicle location systems

Back to the FCC and the storm brewing about the proposed use of the 902MHz-928MHz band for vehicle location systems (VLS, formerly automatic vehicle monitoring or AVM and now sometimes called location monitoring systems or LMS).

Comments being prepared in the rulemaking proceeding in PR Docket No. 93-61 pit entrenched users of the band, including spread-spectrum communications equipment manufacturers, radio amateurs, electronic toll booth manufacturers and low-power communications equipment manufacturers, against the large concerns that have entered the LMS *nee* AVM market with a vengeance.

This proceeding drew a host of comments even before it reached the *Notice of Proposed Rulemaking* (NPRM) stage and promises continued acrimony in the future as interested parties scramble to protect their turf.

Cellular cancer scare

Elected officials in Congress are reacting to the "cellular phone scare," in which

allegations that radio emissions from portable cellphones might cause cancer have raised public concern about cellphone safety.

Congressman Markey is calling for health investigations. Hearing the call, several cellular equipment providers claim that they will engage in independent investigations.

Suddenly, RF energy is a target of criticism, and no one is sure what to do to calm public fears or how far regulation might go to meet those concerns.

If pervasive legislation were adopted, it might require all devices that emit RF energy to be tested to standards for safe operation. Not only would such testing (and equipment re-designing that may follow) create a significant price increase for radio devices, but even-handed legislation would include consumer devices such as dimmer switches, RF light bulbs and computing devices.

One may wonder whether our world soon will be filled with warning labels attached to a myriad of consumer devices. In the time it takes to get up from watching television and go to the kitchen and come back with some microwave popcorn and beer, the typical consumer might pass more than a dozen such stickers. Aesthetic considerations aside, that's a lot of warnings!

What, then, are the industry, the consumer, Congress and all supposedly interested parties supposed to do about this potential health risk? Congress may have to issue a formal statement that says, in essence, "Ya pays your money and ya takes your chances."

Little news media coverage

Although many radio communications issues are under consideration in Washington, these matters receive little news coverage.

The newspapers, TV broadcasts and talk radio programs bring stories every day about impending changes in the health care industry, but the news media have uttered nary a peep about the historic changes occurring in the multi-billion dollar telecommunications industry.

Maybe if Marcus Welby had been a two-way dealer...?

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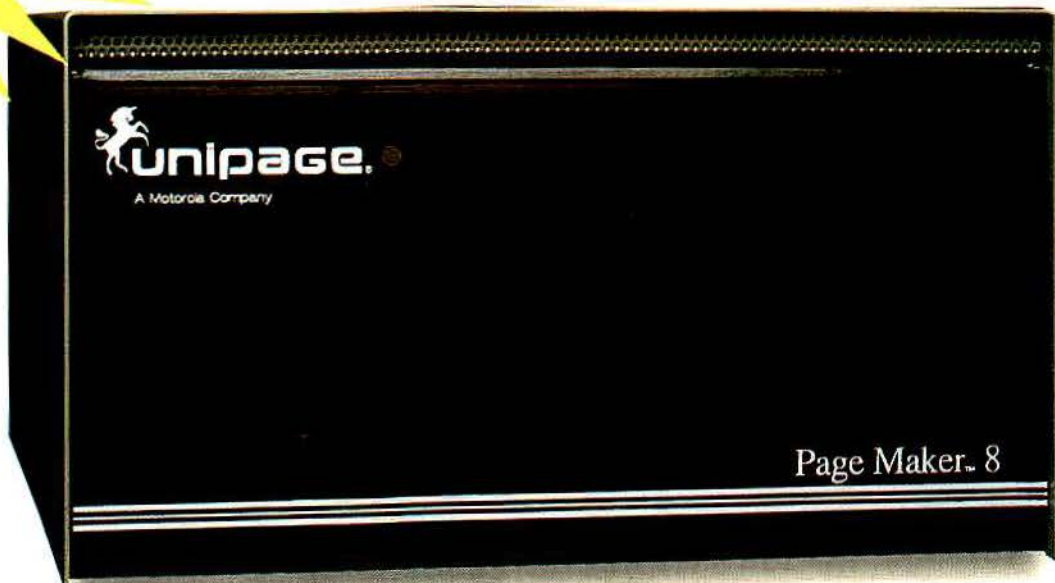


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- Hot Card Maintenance--remove or install any card while the system is operational. It's convenient, and you don't have to power down and lose pages while the system is off the air.
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For more details, give us a call at the Unipage number listed below. We will be happy to show you how the Page Maker 8 is the wise choice for your paging needs.



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Readers' choice

Of all the new products and services in the November 1992 issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them: Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

Tower light monitor boasts automatic dialing

Model 3054 tower light monitor will start dialing three programmed telephone numbers automatically when a tower light burns out. This **Bramco** unit is small and installs easily. Plug into a telephone jack, record a message with built-in mic, program numbers (local or long distance) and connect to "light out" contacts.

Circle (500) on Fast Fact Card

Self-contained PC suits mobile environment



The MDC-890 personal computer from **ElectroCom Communication Systems** features a built-in MDT program for trunking and conventional networks.

The self-contained PC includes durable outer case; high-resolution CRT; external floppy disk port and printer port; 80-character by 25-line screen; and a UPS. The system comes with two internal disk drives and supports any PC-compatible software program. The unit's keyboard is removable and adjusts to any angle. An emergency key is on the front panel.

Circle (502) on Fast Fact Card

Decoder replays DTMF sequences automatically



Model CD-1 communications decoder from **Connect Systems** decodes and displays 104 DCS codes, 50 CTCSS codes

and 16 DTMF digits. The decoder works with service monitors, receivers and scanners. It checks radios and monitors shared repeaters, displaying users' DCS and CTCSS codes, as well as DTMF codes such as ANI, access codes and telephone numbers. DTMF sequences replay automatically in case they were missed the first time or in case the sequence was too fast to observe.

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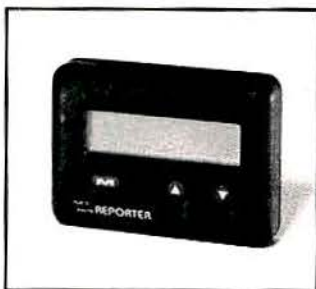
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Circle (61) on Fast Fact Card

Alphanumeric pager offers 640-character memory

The Facts Reporter alphanumeric pager from **NEC America** features time stamped messages; as many as eight user-selectable alert tones; silent vibrating mode; large 12-character display screen; and 640-character memory capacity. The user can program as many as six messages into memory that can be activated and expanded by using a Touch-Tone phone. The pager weighs 2.45 ounces.

Circle (300) on Fast Fact Card



Mobile, repeater extend Radius product line

Motorola has expanded the Radius line with the GM300 mobile two-way radio and the GR300 repeater. The GM300 is available in 8- and 16-channel models, VHF and UHF frequencies, and is dash- or remote-mount capable. It features 1W-25W of variable power, with as much as 45W of fixed power on selected versions. The 16-channel model provides Quik-Call II, MDC-1200 and DTMF signaling formats. The unit meets MIL-STD 810 C, D and E military specifications.

The GR300 repeater is composed of two GM300 mobiles, duplexer, metal enclosure with temperature-controlled fan, repeater interface communications kit, power supply and cables. The repeater is field programmable with desktop control point operation.

Circle (301) on Fast Fact Card



db Mobile's new land mobile antennas.

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If you're looking for an antenna that looks like it truly belongs on your fleet, call 1-800-388-2112. The new land mobile antenna series by db Mobile is the perfect choice that you can make over and over again.

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New products

Cellular antenna offers enclosed-coil whip

The APD854.3 and APD855.3 3dB cellular antennas from Antenna Specialists feature a low-noise enclosed-coil whip. The mounting foot is designed to fit between the defogger wires and to eliminate signal loss.

Circle (302) on Fast Fact Card

Pager comes in a variety of colors

The Sport numeric pager from NEC America offers one-button feature access; 16-message capability; built-in clock and time stamp; and automatic screen lighting. The scratch-resistant pager case comes in pink, green, blue, charcoal and clear colors.

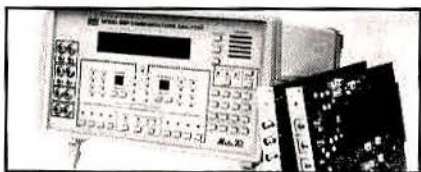
Circle (303) on Fast Fact Card

Software offers accounting solutions for paging, cellular dealers

Easy—Systems paging and cellular accounting software simplifies point-of-sale and related operations for dealers. The SDC software includes Easy-Cell for pager and cellular point of sale; Easy-Page for pager billing; and Easy-Term, the automatic interface for the Glenayre paging terminal.

Circle (305) on Fast Fact Card

Analyzer features expansion slots for plug-in circuit cards



The 300P communications analyzer is designed for digital telecommunications network testing. The unit from Metro Tel

is DACS compatible, provides for DS-0 data access and test and has terminal and monitor modes with 24-channel signal monitoring. It has extra rear-access expansion slots for optional plug-in circuit cards. Standard features include a serial printer port, remote operation via RS-232, talk and dial capability with internal speaker, real time clock, calendar and test timer.

Circle (304) on Fast Fact Card

Canvas cases resist mildew, stains



Leathersmith offers a line of canvas carrying cases for all popular two-way radios and pagers. Made of Propex III canvas, the cases resist mildew, stains, oil and most chemicals. Logos are imprinted at no charge.

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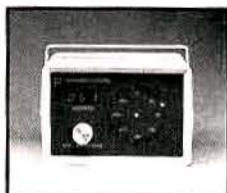
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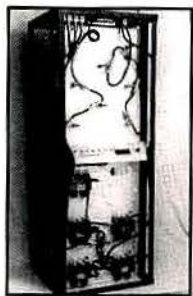
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Circle (64) on Fast Fact Card

Trunking transmitter combiner feeds 5 outputs into one antenna

The M101-220 field-expandable five-channel trunking combiner from Telewave operates in the 216MHz-250MHz range. It combines five transmitter outputs into one antenna with low 2.8dB insertion loss. The combiner



monitors RF power for all channels and the antenna. It can be tuned in the field and it can be fitted with an optional integral duplexer. Telewave offers a line of 220MHz site equipment including model T-2230 tunable isolator; TWPC series of bandpass cavities; model TPRD-2254 series of base station duplexers; model ANT220F6 fiberglass collinear antenna; model ANT220D halfwave dipole; model ANT220D3 exposed dipole array; and model ANT220D6-9 exposed dipole array.

Circle (307) on Fast Fact Card

How can Bendix/King afford to offer a **5-year warranty?**



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We designed the EMV mobile UHF radio to elevated standards, then set our manufacturing and testing standards even higher. The result: total confidence. That's why we cover the EMV with the land mobile industry's best warranty: *five full years* at no additional charge.

The EMV's extruded housing, die-cast frame and surface-mount internal components afford extreme rigidity and resistance to vibration. Its rugged construction meets demanding MIL-SPECs 810 C, D and E.

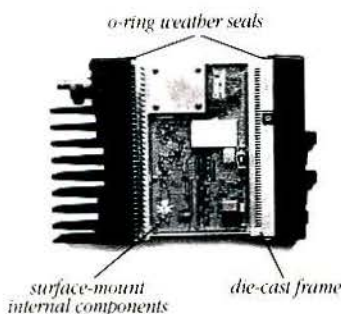
Extensive testing of components and circuits ensures reliability. *Every* unit withstands an 8-hour transmit/receive temperature-cycling burn-in test before acceptance as a finished product.

And we haven't sacrificed power, performance or flexibility. We've put features and options under high-performance digital control, written into system software, so there's never a need to open the case for adjustments.

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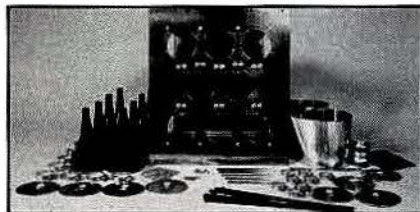
New products

Car-Kit features CMX745 antenna

Ora Electronics' Car-Kit features the CMX745 Thru Glass cellular antenna with clam shell mount and cradle with vehicle adapter. The Car-Kit is a convenient in-vehicle adapter kit that provides the user many of the features and the performance of an installed car phone.

Circle (308) on Fast Fact Card

Entrance panels feature 1/8" half-hard copper



A series of grounded bulkhead entrance panels facilitate transmission line entry into a communications building. The entrance panel from PolyPhaser is made of 1/8" half-hard copper with threaded holes for interconnections with extra surface area. The panels are available in 3-, 5-, 8-, 16- and 24-port sizes.

Circle (309) on Fast Fact Card

Three products added to mobile data, ANI line

Coded Communications has added the following products to its line of mobile data and automatic numeric identification (ANI) equipment: the CMX-4500 mobile data terminal, the CMX-1000 mobile status terminal and the CRT-1000 ANI display.

The CMX-4500 mobile data terminal sends, receives and stores as many as 10 forms or dispatches of eight lines each. It sends status and numeric-only messages, and an LCD allows viewing of two lines at

Radio modem does not require an FCC license

The NLR-96 radio modem from Repco uses spread-spectrum radio modulation and does not require an FCC license. The NLR-96 connects directly to any RS-232 data source and transfers data. Two interface modes are RTS/CTS handshaking and a three-wire direct connect. The modem can be configured for synchronous or asynchronous operation and is available in 120/240Vac or 12Vdc versions.

Circle (310) on Fast Fact Card

Watch contains pager

The Receptor MessageWatch contains a tiny FM receiver and antenna to receive messages. Transmission options include phone numbers with as many as 16 digits, standardized messages such as "Call Home" and "Call Office," and nine coded messages. All messages entered into the unit can be retrieved over the telephone as long as 96 hours after being sent. The MessageWatch from Seiko Telecommunication Systems offers a dual-zone time system, allowing one to keep time in an additional time zone.

Circle (311) on Fast Fact Card

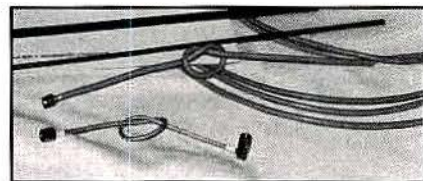
Hump-mount leaves room for airbag deployment

The SDI 580 straddle hump-mount base plate is a solid platform for either build-up mounts or for a permanent installation of two-way radio devices. The mount from Scientific Dimensions allows enough flexibility in build-up mounts to leave room for airbag deployment in vehicles.

Circle (313) on Fast Fact Card



Flexible coaxial cables replace semi-rigid cables



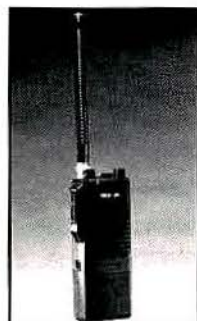
The T-flex flexible coaxial cables from Times Microwave Systems replace the company's semi-rigid cables in both new and existing applications. Attenuation specifications for the T-flex cables match the MIL-C-17 requirements for the semi-rigid cables they replace. The cables are specified for use at frequencies as high as 2GHz.

Circle (314) on Fast Fact Card

Radio doubles as a talk-back pager

Three signaling formats—CTCSS, DCS and two-tone sequential—are standard built-in features to the Mini-Com PTV56 portable radio from Relm Communications. When used with a two-tone paging system, the two-tone sequential decode allows the PTV56 to double as a talk-back pager. The 5W, 6-channel 150MHz-174MHz radio measures 5 1/4" high x 2 1/4" wide x 1 1/4" thick. Accessories include drop-in battery chargers, speaker microphone, DTMF pad conversion and a leather carrying case.

Circle (315) on Fast Fact Card



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Circle (66) on Fast Fact Card

Mounts feature built-in connectors

The MCM series of magnetic mounts with built-in connectors are ideal for hand-held radios and phones. Available from **Maxrad**, the mounts allow the antenna to be removed from the portable unit and placed on top of the vehicle for improved performance.

Circle (316) on Fast Fact Card

Antenna withstands winds as high as 128 miles per hour

The ASPH682 is a 250W 6dB gain omnidirectional vertical collinear antenna that offers a VSWR better than 1.5:1 in the 220MHz-222MHz frequency range. The antenna from **Antenna Specialists** has an Armor-weave fiberglass radome protecting the radiating elements. Because of the antenna's rugged construction, it has a rated wind velocity of 128 miles per hour with a 1.65 safety factor.



Circle (317) on Fast Fact Card

Software utility offers variety of programs

CommShop version 3.0 from **Direct Communications** includes the following programs: range analysis profile and report; coax cable loss; duplexer isolation requirements; intermodulation predictions; battery life estimator; two-tone paging frequencies; and volts to watts to dB conversion. CommShop is available in 5.25" or 3.5" formats for IBM PC and compatibles with DOS 3.2 or above.

Circle (318) on Fast Fact Card

Battery withstands temperature of -20°C to +150°C

The TL-6520 medium-power lithium cell is a "C" size, spiral-wound battery with an open circuit voltage of 3.9V and a nominal voltage of 3.7V. The cell is rated over a temperature range of -20°C to +150°C, with as much as 500mA of continuous current and pulses as high as 1A. The TL-6520 from **Tadiran** is available in a large 0.649" diameter S-type, flat-button, pressure contact for easy stacking or T-type, nickel-strip, flat solder tabs.

Circle (319) on Fast Fact Card

Viking series offer multiformat 800MHz trunking

The Viking XR series hand-held and SR series mobile from **E. F. Johnson** are multiformat 800MHz radios, which means they work with LTR and AmeriCom systems. Both radios have an LTR talkaround mode and are capable of 20 systems with 10 groups per system, with both system

Circle (320) on Fast Fact Card

Analyzer evaluates receiver performance during operation

The STel-300 communication performance analyzer evaluates the content of received signals and yields metrics sensitive to interference and other anomalies in amplitude, frequency and time. The STel-300 is designed to work with a BPSK/QPSK/MSK receiver to provide perfor-

mance measurements during normal operation. The unit by **Stanford Telecom** observes the receiver's performance during operation without the need for test patterns, transmission disruptions or other support equipment.

Circle (321) on Fast Fact Card

Radio console monitors as many as 10 base stations

Model C-5111 10-line, four-frequency radio control console from **Vega** selects one or any combination of 10 remote base stations for transmit and receive. A second speaker allows monitoring of any combination of those 10 stations that are not already selected for transmit and receive control. Instant push-to-talk switches allow immediate response to a call on a particular selected or unselected line without disturbing the programming of the selected simulcast group or line.



Circle (322) on Fast Fact Card

Signal generator tests CTCSS, DTMF, selcall systems



The PSG2400A synthesized signal generator features two internal, wideband modulation sources covering 0.1Hz to 500kHz with either sine or square waves, allowing the user to produce complex modulation waveforms for testing CTCSS, DTMF and selcall systems. As many as 16 unique, consecutive tone bursts can be defined along with the standard 5-tone selcall systems. The unit from **Wayne Kerr** covers the 100kHz to 2.4GHz frequency range.

Circle (323) on Fast Fact Card

(More New products on page 77)

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Circle (68) on Fast Fact Card

Literature

Membership directory includes buyers' guide

A membership directory and buyers' guide from the **American Mobile Telecommunications Association (AMTA)** is designed to serve as the "Who's Who in the SMR Industry." The directory is divided into five parts: basic association information; information about the association's products and services; an SMR industry overview; membership directory; and a products and services section, which is a complete listing of the hardware and software providers of SMR equipment and peripherals, as well as service providers such as consultants, brokers, lending institutions, venture capitalists, valuation companies, marketing resource specialists and insurance brokers.

Circle (250) on Fast Fact Card

Brochure describes wideband transformers

A 10-page illustrated, color brochure describes **North Hills'** line of off-the-shelf wideband transformers. Included in the brochure is an applications section offering design information, as well as a specification guide for custom requirements. Products covered include isolation transformers, baluns, coaxial impedance adapters and power dividers.

Circle (251) on Fast Fact Card

Catalog lists signaling products

A catalog from **Sigtone** describes its products, including automatic number identification (ANI), selective calling, CTCSS, status reporting and computer-aided data dispatch systems. Product descriptions, features and benefits are included, as well as many photos and illustrations. A product selection matrix and a list of signaling modules are in the back of the catalog.

Circle (252) on Fast Fact Card

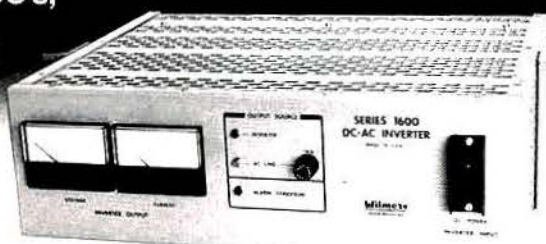
Booklet lists glossary of terms

A free booklet from **S-Com Computer Systems Engineers** has been produced to help systems staff deal with the evolving technology of mobile data over radio networks. The company hopes to create both interest and awareness by adding to the booklet's introduction a challenge to the readers: the people who offer the three most original additions to the booklet will be given a small prize.

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Feedback

Readers use the buyers' guide all year long

The annual *MRT* buyers' guide stays with readers for 12 months or longer, according to 55.6% of the respondents to the December 1992 "What Do You Think?" questionnaire. Other respondents keep the magazine for the following amount of time:

1 to 2 months	2.2%
3 to 6 months	11.1%
6 to 12 months	31.1%

Readers find the following categories in the buyers' guide the most useful:

Products and services	60.0%
Addresses	42.2%
Index to features	22.2%
Brand names	15.6%
Trade association listings	11.1%

- "(The buyers' guide) is helpful because I learned about some brands that I did not know about them."
- "Summary of features was very helpful."
- "The buyers' guide contains all the companies, addresses and phone numbers needed. It's a big help!"

Readers plan to use the buyers' guide as follows (multiple answers add up to more than 100%):

To contact vendors directly	66.7%
To file for purchasing reference	64.4%
To circle numbers to receive literature	64.4%
Other	11.1%



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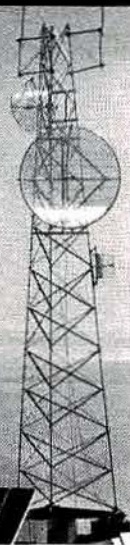
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Changes at the Cellular Telecommunications Industry Association (CTIA), Washington, DC:

Wayne M. Perry, vice chairman of the board of McCaw Cellular Communications, Kirkland, WA, has been elected chairman of the CTIA board of directors.

J. Sharpe Smith leaves Phillips Publishing International, Potomac, MD, as editor of *Land Mobile Radio News*, to join CTIA as public affairs writer.

Erik H. van der Kaay becomes corporate vice president of the Allen Group, Cleveland, adding to his responsibilities as president of the Allen Telecom Group, Cleveland, and president of The Antenna Specialists, Cleveland.

Harry A. McQuillen becomes president and chief executive officer of Overland Park, KS-based Intertec Publishing, adding to his responsibilities as president of New York-based K-III Communications' consumer magazine division and group vice president of K-III Magazine Group, which includes all of K-III Communications' consumer and trade publications. K-III Communications owns Intertec, which publishes *Mobile Radio Technology*. McQuillen replaces **R.J. Hancock**, who continues as a consultant.

Raymond E. Maloney advances from Intertec vice president of finance to become executive vice president of Intertec.

Sam Rizk departs AT&T Microelectronics, Allentown, PA, as business development manager to join MX-Com, Winston-Salem, NC, as marketing vice president.

Randy Burch leaves Energy Service Company, Dallas, as treasury manager to join Jefa International, Plano, TX, as chief financial officer.

Michael K. Morin, president of Comsearch, Reston, VA, a division of the Allen Telecom Group, adds to his responsibilities by becoming chief executive officer. He replaces **Harry L. Stemple, III**, the former chief executive officer and founder.

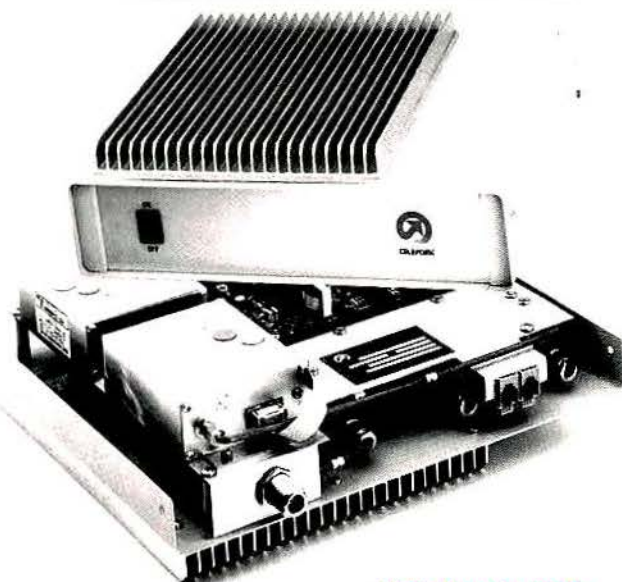
Bill Schwartz joins SoftWright, Aurora, CO, in the software design and product support department after graduating from the University of Colorado, Boulder.

Frank A. Thatcher, P.E., 64, president of Frank Thatcher Associates, San Francisco, died April 24 of cancer. The company continues to provide professional services under the management of **Charles Ostrofe, P.E.**

Jose Santana was named top international sales manager for 1992 by E. F. Johnson, Burnsville, MN. He received both the Goal Maker award and the President's Viking Club award for exceeding his personal 1992 performance expectations.

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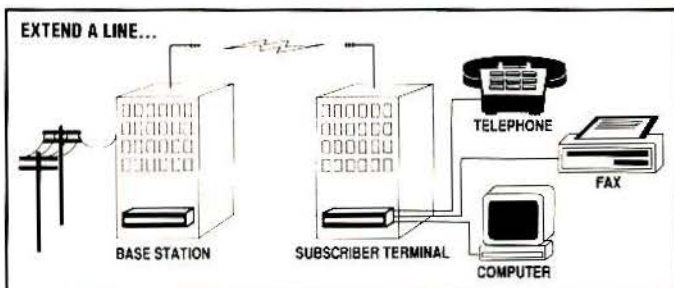


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Circle (73) on Fast Fact Card

Trunking:

George Weimer's April 1993 letter to the editor responding to my December 1992 letter raised some valuable points about trunking technology.

An astute radio system manager can divine a wealth of system performance data, which is a valuable tool for justifying system growth; however, quite a pile of paper can be collected on the day-to-day performance of conventional systems, too.

The key problem is making the meaning behind the data clear to people who have little background in radio technology—the people who decide to budget or not to budget for system growth.

Here, the advantage of trunking turns to a disadvantage.

The people who have budgeted conventional systems have become used to signs of capacity shortage, including simply being able to ask or to be told by system users that there is a problem and that it needs to be fixed. The very nature of trunking tends to mask this traditional feedback, leaving the system manager with a wealth of data but little in the way of visible problems.

No viable standards exist that the manager can use to support a case for spending very tight public safety budget money on radio system growth.

How much capacity above daily average and peak use should an average public safety trunked system have?

A system manufacturer cannot provide that data without the data being viewed as being biased toward the sale of equipment. The local manager can establish opinions, but in tight budget times, locally derived opinions tend to get put aside until a real and usually serious problem forces the issue. In public safety, that can be too little too late.

One approach to add weight to local management data is to establish viable national and regional system loading and minimum capacity standards. The Associated Public-Safety Communications Officers (APCO) would be a good choice to develop this needed perspective.

A key objective would be to establish standards that take into account not only local daily use, but also additional capacity needed for emergency management and even system considerations such as loading during VIP visits.

Trunking is not all that different from conventional radio systems when it comes to the need to ensure that reserve capacity is available for users on demand.

Because trunking tends to mask a lack of reserve capacity, however, the need is greater for local system managers to communicate with their associates and to join

forces in establishing standards that can stand up to the pressures and demands of the local annual budget meeting.

Rand G. Ellis
Marketing Manager
Radio Systems
Fort Lauderdale, FL

EMRS:

Your March editorial comment concerning the establishment of the Emergency Medical Radio Service (EMRS) could not have come at a better time.

It appears as though the EMRS will help to relieve the heavy load that the Special Emergency Radio Service (SERS) frequencies carry.

As you noted, ALS units, BLS units, rescue squads and EMS providers require quick access to airtime when the difference is life or death for those who depend on the numerous paramedics, emergency medical technicians, firefighters, hazardous materials team members and first responders.

The establishment of EMRS had some of us concerned about how we would be affected by the new service. The EMRS will not affect our operations in a big way. If the FCC decides to consolidate the numerous private land mobile radio services into the three you mentioned, we most likely will come under Public Safety Radio.

Which brings me to the question of how will all this affect mutual aid radio (MAR) frequencies?

Many cities use MAR not only for response but for coordination, too. Most EMS providers and rescue squads have MAR communications capabilities.

The ability of neighboring agencies to respond to large-scale incidents and disasters and to coordinate response activities in a nearby area is important to all concerned. Otherwise, chaos very likely would result.

Daniel L. Bailey
Emergency Operations Supervisor
Sabine Pass Storm Spotters
Groves, TX



Mobile Radio Technology

The journal of mobile communications technology

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New products

(Continued from page 71)

Mobile offers built-in modem

Midland LMR has added an internal modem for its Syn-Tech XTR two-way mobile radios and desk-top base stations. The built-in radio modem is capable of data rates as high as 9,600 bps and supports RS-232 or TTL interfaces. With the internal modem, data sources such as GPS receivers, vehicle sensors, mobile data terminals and personal computers can be plugged directly into the radio; no extra boxes are needed.

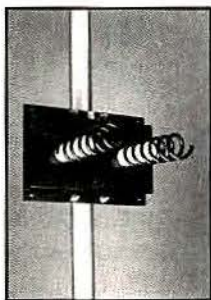
Circle (330) on Fast Fact Card



Base station antenna covers 1.6GHz to 2.4GHz

The DH14-2000 dual helix base station antenna from Mobile Mark is applicable for fixed, portable or mobile applications. The antenna covers the 1.6GHz-2.4GHz range, offers 14dB gain and is useful for point-to-point communications. The antenna can be ordered with horizontal, vertical or circular polarization.

Circle (331) for Fast Fact Card



Local extension offers on-hook PTT



The LE10 from CPI Communications is a telephone-style local extension designed for use with virtually any radio. The LE10 provides LED PTT indication, on-hook PTT capability,

off-hook monitor, amplified speaker with volume control and adjustable amplified modulation output. Options include a wall-mount package, two channel control, intercom, on-hook monitor and plug-in power pack.

Circle (332) on Fast Fact Card

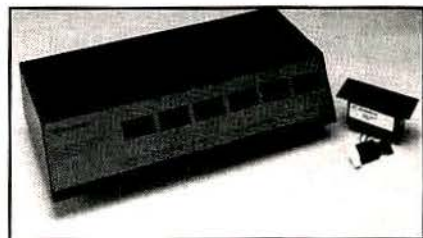
Converter features vibration, moisture protection

The ICT 2412-20AS converts 24Vdc to 12Vdc and features Mosfet design, over voltage protection, current limiting and modular construction. The unit is assembled with four types of silicones and two types of Loctite to ensure against vibration and moisture. The small, compact case has accessible mounting holes for easy installation and is constructed from anodized aluminum.



Circle (333) on Fast Fact Card

Battery maintenance system holds six batteries



Circle (334) on Fast Fact Card

The battery maintenance system (BMS) from Motorola is a six-station universal battery servicing unit that interfaces with many batteries via interchangeable adapters (ordered separately). The unit can maintain any mix of Motorola or Mag 1 batteries simultaneously. The BMS displays and tracks battery status, mAh and voltage.



Interference patrol

Responsibility for controlling interference on shared channels lies first with radio users:



- Listen before you transmit on a shared channel. Learn how to disable the squelch to listen for other users.
- Use your call sign whenever you use the radio.
- If you use a scrambler for privacy on a shared channel, sign off "in the clear" so other users know you are finished.
- Have your radio serviced periodically to be sure it is on frequency.
- Keep communications brief to promote harmony with other users who share the channel.
- Use the minimum transmitter power and antenna height you need to cover your area. That might be less than the power and antenna height specified on your license.

System operators:

- Post the name and 24-hour phone number of the site manager at the access point for each antenna site.

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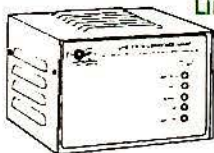
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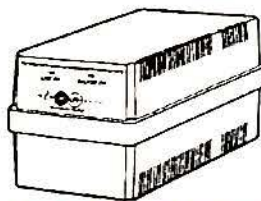
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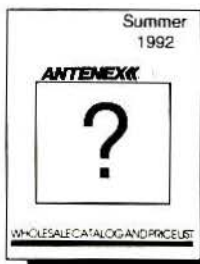
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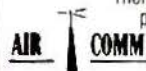
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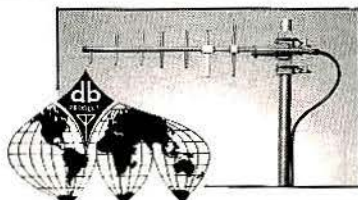
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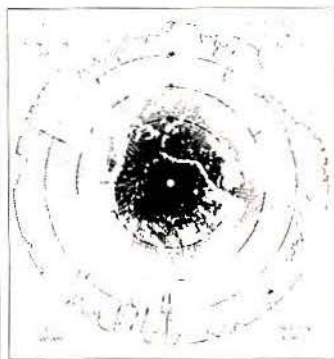
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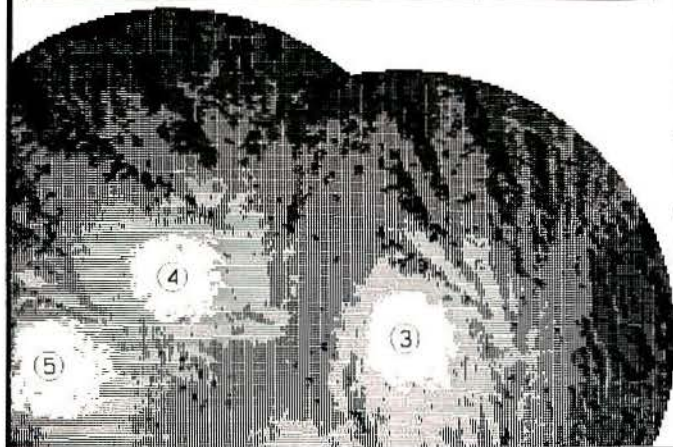


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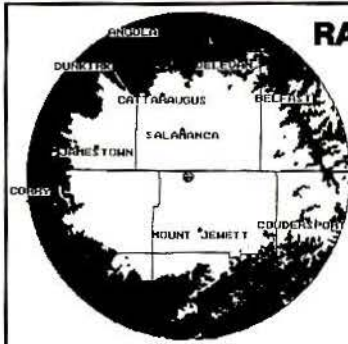
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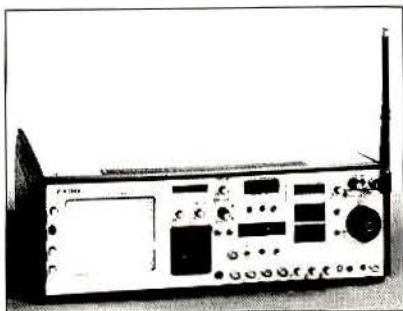
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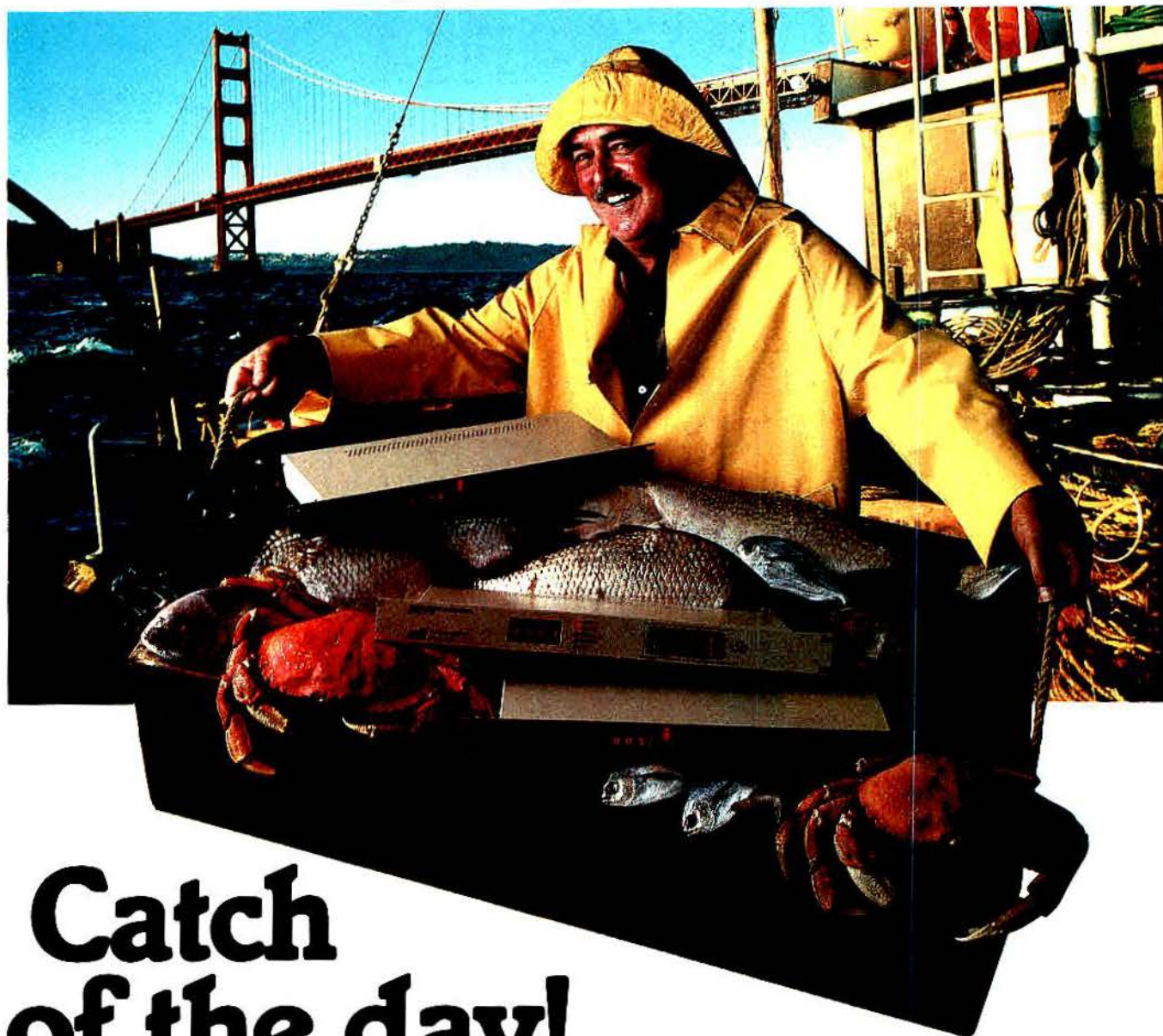
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